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FOR WHAT SHALL WE TEST?

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The writer has a nephew who was a navigator for a bomber crew in World War II. His job was to keep the pilot appraised of the plane's whereabouts in order that it quickly reach the target and return with certainty to the home base. To do this he had to make reckonings with reference to many disturbers of the plane's motion and safety.

After several years' experience he might, conceivably, have made shrewd guesses in regard to such matters and upon the basis of such guesses or hunches, have issued directions which were approximately right for such purposes. However, his training and superior in command were both unalterably opposed to such a plan for navigation! Instead his duties included making measurements of plane's speed, wind velocity and direction, altitude and altitude variations, temperature, change in terrain contour and other variants. After these measurements were made they were then used to get the answer to the questions: "Where are we with reference to our target?" and "Should we change our original plan in order to get there more quickly and with greater certainty?" Throughout every mission the navigator was carefully and continuously testing. To what end? His crew had an assignment; it was his job to help them accomplish that assignment in the shortest possible time with the greatest degree of certainty. He relied almost wholly upon tests. The tests, however, were used as a means to an end. They were not ends in themselves. Considered in isolation they were of little

worth. There were many tests which he did not make. Why? Because their results would add nothing to the basic information needed to help reach the target with speed and certainty.

All concerned with a bomber mission had two all-important objectives for each mission: (1) reach the target and (2) safe return. For each school subject there are likewise two (maybe more) objectives: (1) achievement of information and understanding and (2) development and practice of desirable personality traits.

The teacher of a course in school has to serve as both navigator and pilot. Too often the immediate demands of the pilot's job eclipse the overall need for navigation and the educational "craft" wabbles about "off beam."

For each individual bomber mission it was often necessary to break the general objective "reaching the target" into sub-aims such as "crossing a large body of water," which made specific navigational demands not required by land contour, or there might be a land elevation such as "a range of mountains to scale" which would vary the navigator's prcedure.

Similarly the general subject-matter aims such as "information and understanding" may need particularization into "aspects of information" such as: vocabulary for precise expression, principles or laws which epitomize the basic facts and relationships and typical situations out of experience for use in probing for understanding. Personality traits may be defined in terms of pupil's ability to *do* by: practicing and improving skill in getting *evidence*, becoming sensitive to the social values of information and becoming alerted to the hazards in sophistication, etc. Once these "compasses" for "navigation through the course" have been identified it then becomes the duty of the "navigator" to devise ways and means of knowing whether the program of that course is moving as "their needles" point. It is to this end that "soundings" must be made and the findings that result need to be used to make more certain proper direction of the program and the rate of its approach to the desired information, understanding and traits. It at once becomes obvious that the answer to the caption question is "we test to get evidence of progress toward a subject's objectives and to furnish a basis for any modification of the program for the attainment of those aims more effectively and speedily."

Just as the bomber crew was required to go through a thorough and detailed program of "briefing" for each mission so our

schoolroom "navigator" should institute a thorough and detailed analysis to fully isolate and identify the various elements in the composite general objectives of the subject. In a particular bomber mission there were identifying types of contour, or pre-charted quirks of atmospheric movement. So each aspect of a subject's contribution to understanding and personal development may, on analysis, have specific excellences or deficiencies for attaining the complete purpose of the course.

To formulate a workable answer to the title question requires, in a sense, a sort of "job analysis" upon the part of the teacher if he is to become both an educational "navigator" as well as a classroom "pilot." Help in achieving such analyses and the formulation of the "job items" in the language of pupil behavior has been prepared for various subjects. A limited listing of such helps may be in order at this point:

For:

Botany: Horton, Clark W., "Achievement Tests ... in General Botany," pp. 7–11, Bot. Soc. of Amer. Miscel. Series Pub. No. 120 (1939).

Chemistry: Hendricks, B. C., and Smith, O. M., "Measurable Objectives for General College Chemistry," SCHOOL SCIENCE AND MATHEMATICS, 36, 747–752 (Oct. 1936).

General: Tyler, R. W., "Formulating Objectives for Tests in Constructing Achievement Tests," Ohio Educ. Research Bul. 12, 199 (Oct. 1935).

The essence of the content of the references given is that "aims of the course must be phrased in the language of behavior so that in trying to identify the accomplishment of those aims the appropriate behavior serves as a criterion." Testing then becomes a matter of uncovering the changes which the behavior of students have experienced as they are influenced by that study from day to day.

The failure of carefully phrased objectives of different school subjects to produce desirable modifications of classroom instruction in the past is, to a large degree, attributable to the inability of teachers, seeking to use such aims, to actually become aware of the effects of that use. They could not tell for certain that the change proposed in the objective had been produced in the behavior of their pupils as a result of that objective's use.

In 1932 the National Society for the Study of Education issued its Thirty-First Year Book, Part I, ***A Program for Teaching Science***. On page 257 it listed thirteen "Objectives of Chemistry." The statement of these objectives is, in every case, phrased

in very general terms: "To give . . . a broad appreciation . . . To satisfy natural interests, ... To develop broad concepts . . . To contribute specific ideals, habits, ... To develop system, order, neatness, ..." After each, almost without exception, the conscientious classroom teacher could raise the question, "How may I know if my pupils have "developed," or "satisfied" or "been given" any of the attitudes, ideals, appreciations, etc. there listed?" "What can my pupils do to show that result?"

A modification of the phrasing of somewhat similar objectives is illustrated in *Science in General Education* (published by Appleton-Century 1938), page 466. Here statements are notably more functional; the pupil behavior is more explicitly stated and in consequence the evidence of behavior change more certainly identifiable. A perusal of these objectives finds such purposes as: "The study of chemistry: . . . aids *me:* . . . to study and investigate problems (of my own); to discover and develop wholesome leisure-time activities; select and use goods and services; to explore vocations; gain some knowledge of health and health habits etc."

In summary: It would seem reasonable to assume that each teacher expects something to change about his pupils as they work with him upon a given course. If he expects change he should have means at hand by use of which he can gauge that change. Such indicators of change whether they are diary records, class responses or pencil and paper examinations are tests serving the "educational navigator" to be more certain of reaching his "target," and with enough carry-over to make "after-target" activities possible and probable. A schoolroom course might be "navigated" without tests, by depending upon guesses, hunches, and intuitions, but should such practices in the classroom rate higher approval than they do when applied to aerial navigation?

NEW INSTITUTE OF BIOLOGY WILL BE COORDINATING CENTER

An institute of biology, to serve as a coordinating center for the many diverse special biological societies in this country, was planned during the meetings of the American Association for the Advancement of Science at Boston.

The National Research Council has undertaken the task of organizing the new institute, and will finance its initial operations, which will be conducted within the framework of the Council. If later on the institute wished to carry on its work independently, it was agreed that it will be at liberty to do so.

SOME INDUSTRIAL EFFECTS OF QUALITY CONTROL BY STATISTICAL METHODS*

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The topic suggested, "Some Industrial Effects of Quality Control by Statistical Methods" is an extremely easy one to discuss. Expecially so in view of your general theme, *New Power*, *Products* and *Personnel* since statistical quality control involves each of the three phases.

In order to appreciate better the industrial effects of quality control it may be profitable for us to consider a few of the fundamental concepts, to give a brief history of the subject, to mention the growth of its use during the last few years, to comment on its present status, and tendency for future development, and possibly to suggest changes or lack of changes in our work as educators.

It is natural for one to ask "What is Quality Control by Statistical Methods?" Many answers have been given to this query. In so far as the writer knows, none has been entirely satisfactory, in that none has been broad enough to include the entire area and, at the same time, specific enough to give an adequate meaning. Probably the phrase is self-explanatory. It is a means whereby the quality of a product is controlled by statistical methods or procedures. Its specific meaning varies according to the industry in which it is applied and to its use on a particular project. One outstanding industrialist has referred to Quality Control by Statistical Methods as " . . . a new approach to the quality problem that places decisions on a *factual* statistical basis. It is often referred to as the missing link between Production, Inspection, and Engineering."[1]

In any case it is well to recognize that the field is a broad one. Applications are being made in such industries as aircraft, candy, chemicals, clay products, drugs, electrical equipment, farm machinery, food, foundries, glass, mail order, metal working, optics, paper, plastics, radio equipment, rubber, seeds, small arms, steel, surgical dressings, telephone, textiles, and tools. New uses are being discovered constantly and additional concerns are making use of it as more individuals are trained. It

* Presented at the annual convention of the Central Association of Science and Mathematics Teachers in Detroit, Michigan, on November 29, 1946.

[1] *Quality Control*, Deere and Company, Chicago, Illinois, Fred J. Halton, Jr., Assistant to President, *et al.*

has proved to be particularly desirable when applied to new lines of production and where it is necessary to utilize inexperienced labor. Quality Control by Statistical Methods is of utmost importance where *quality counts*—whether we are concerned with the manufacture of goods, the acceptance of materials, or the work in an office. It is worthwhile to consider its usefulness whenever a process is repetitive.

Two fundamental principles are *variation* and *measurement*. The fact that no two things are exactly alike—even though these differences are small—is being recognized in industry today. Also the principle that "Anything that exists, exists in some amount, and that amount can be measured"[2] is being realized.

Mathematical statisticians together with the aid of industrial representatives have developed sound statistical theory which has been perfected to such a degree that the results of a process can often be pictured on a *control chart*. A control chart is relatively simple. It has been likened to a highway as indicated in Figure 1.

HIGHWAY	likened to a	CONTROL CHART
Highway	Traffic System*	Control Limits
DITCH	RED-DANGER	
		Upper Specification
SHOULDER	YELLOW-CAUTION	
		Upper Control Limit
PAVEMENT	GREEN-SAFETY	
		Lower Control Limit
SHOULDER	YELLOW-CAUTION	
		Lower Specification
DITCH	RED-DANGER	

* The color scheme was worked out with the cooperation of E. L. Fay, Chief Inspector, John Deere Tractor Company, Waterloo, Iowa.

Fig. 1

In a manufacturing plant, in a shop, or on a production line random samples of, say five items, are selected periodically. The *average* and *range* of each sample are determined and plotted on respective control charts. When twenty or more pairs of plottings have been posted action lines (upper and lower control limits) are computed and drawn on the chart.[3] If a plotting falls

[2] "How Will Quality Control Reduce Costs?" James M. Ballowe, Production Series Number 162 American Management Association, pp. 25–35.

[3] A detailed explanation of the construction of control charts has been published by the writer in *Industrial Quality Control*, "Fundamentals of Quality Control," July, 1946, pp. 7–18.

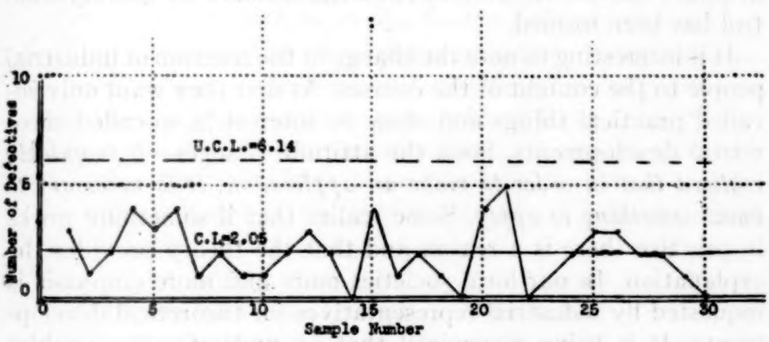
outside either action line (control limits) attention is focused on the process to determine if an assignable cause can be found and if it is economical to have it eliminated. As assignable causes are discovered and eliminated production tends to increase, a considerable amount of material is usually saved, and much more efficient operation results. Corrections, if necessary, are made where the work is performed at the time it is performed—not two or three days later after the product has been produced.

Various types of control charts have been devised. A second rather common one is the fraction defective chart as indicated in Figure 2.

A TYPICAL CONTROL CHART

Control Chart based on samples of size 50 taken from a controlled process at 4% defective.

Control limits based upon first 20 samples—in control, satisfactory level so limits extended and record continued.



Note: 1. The chart indicates control at 4.10% on only 20 samples and exactly 4.00% on the 30 samples.

2. More samples contain 4% than any other single percent; more samples contain less than 4% than contain more than 4%.

3. This predictive value of a control chart is customary.

FIG. 2

It will be recognized that the heavy solid Central Line (C.L. =2.05) is drawn at the average number of defectives, while the heavy broken Upper Control Limit (U.C.L. =6.14) is drawn at $n\bar{p}+3\sqrt{n\bar{p}(1-\bar{p})}$. (This provides another interesting use of the binomial expansion $(\bar{q}+\bar{p})^n$, where $\bar{p}=.0205$, $\bar{q}=1-\bar{p}$, and $n=50$.)

As with many other important developments, mathematicians laid much of the foundation of quality control many years ago. At that time some of the "practical minded folks" thought of it

as only a theoretical idea—something that would never be used.

In the early twenties a few of the large industrial organizations, notably Bell Telephone Laboratories, began to make use of quality control by statistical methods, but it has only been during the last few years that its use has become widespread. During World War II the Office of Production, Research and Development in cooperation with educational institutions sponsored 34 intensive eight-day courses on the subject—we at the State University of Iowa were fortunate in being able to cooperate with two of them. A few intensive courses have been sponsored by some schools since the end of the war—we have since given our third and fourth courses. Over two thousand industrial representatives from five or six hundred industries have attended these intensive courses. Many more have been initiated through in-plant training courses and by attendance at local societies. In fact, the American Society for Quality Control has been formed.

It is interesting to note the change in the reaction of industrial people to the content of the courses. At first they want only so-called practical things and show no interest in so-called theoretical developments. Soon the attitude changes—*it is quickly realized that in order to make an application, it is necessary to know something to apply*. Some realize that if something works in practice there is a reason and that the theory provides the explanation. In our local societies more and more emphasis is requested by industrial representatives for theoretical developments. It is being recognized that an understanding enables further progress and a greater number of successful applications. In fact, the most difficult problems of a theoretical nature encountered by the writer during the past few years have originated in the shop or in the office by persons extremely interested in applications.

One may wonder what relation the use of quality control technique in industry has to our work as educators. One might suspect that the writer would advocate teaching quality control in secondary schools. On the contrary such a suggestion—the teaching of statistical quality control, as such—would be quite out of order. The principle still holds that schools should teach fundamentals. We do not know what practical applications will be in use in twenty or ten or even five years. But we can predict that the fundamentals will be sound then as now.

However it is desirable that as educators we be aware of new

developments and new applications of the fundamental principles that we are teaching. Examples are desirable to make the work more and more interesting. It is probably well for us to realize the increased activity in this area, to spend even more time on the fundamentals of mathematics, and to mention some ideas of variation and measurement as examples. But the most valuable thing that teachers in secondary schools can do for quality control is to help our students acquire a thorough mastery of the fundamentals including such concepts as ratios, percentages, facility for numerical calculations, possibly an elementary knowledge of probability, and of frequency distributions including the graphical representations thereof.

We should realize, however, the far reaching effects of a quality control program and the understanding necessary for such operation. Savings have been spectacular—it is not unusual for a saving of twenty or thirty dollars per day to be reported on a relatively simple operation, or of a weekly saving in material of several hundred dollars on a production line. Sampling procedures are being revised—the fallacy of the common procedure to take 10% samples is becoming recognized. Design and specifications are being made on a scientific basis taking into consideration a knowledge of what a process will do, not what the engineer hopes it will do. The proper design for an experiment is receiving additional attention.

Probably one of the most valuable places in our curriculum for a course in Statistical Quality Control is at the college or university level after the prospective quality control engineer has had the benefit of at least two years of college mathematics. It is suggested that the course be an *elective* one *available* and *accessible* to all qualified students, not merely a course somewhere for which it is difficult to register. It is then possible to have sufficient interest and background to obtain an understanding of such depth that one is most likely to succeed in an area which is having a significant effect in industry and which promises to be a permanent one.

Electric light bulb, flaring to twice or more the width of the ordinary globe-shaped bulb, provides both direct and indirect lighting. The top flat end diffuses light upward through a special frosting, while other light diffuses downward through an opalescent coating on the sides.

THE USE OF STUDENTS' PROJECTS IN RESEARCH

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The value of student projects has been attested by innumerable articles in many different journals. Project methods are used at various age and grade levels between the lower grades and graduate school. These projects stimulate individual interest, group interest, and are also highly instructional in that they disclose factual information, and present pragmatic applications to daily activities. As merely something to do or as stunts the value of projects is very limited. Students of all ages have little appreciation for pointless work. Pre-professional students who plan to enter teaching, other educational fields, or who want to acquire technical methods prefer to extend the significance of any work, which requires considerable effort, beyond the confines of a particular technique or class room task.

In the present study advantage has been taken of this general attitude by utilizing student efforts in projects which impinge upon some phase of a basic research problem in pure science.

Many teachers training institutions operate essentially as liberal arts colleges in which professional education is treated as a departmental area. Chicago Teachers College is unique in that its students are given a wide range of subjects with view to fitting them with a very general education as a basis for teaching in elementary schools operating under the Chicago Board of Education. These students are not regarded as candidates for any graduate school and there is no emphasis on specialization. Students designated as science majors have not concentrated their study in any especial area so that there are no majors in biology nor in physical science much less in the various categories into which these great branches can be divided.

It is obvious that two or three courses in zoology or botany cannot qualify a student for research work. However, many students have a keen interest in scientific discovery. Chicago Teachers College students who are designated as science majors or minors and whose scholarship is better than average may be elected to an honorary scientific organization within the college. The faculty sponsor of this organization presents to the students problems or publications which are used as starting points for

pathways of investigations that appear to be of scientific value. The problem, where possible, is broken down into simple steps or projects. Any student who wishes to participate may select one of these. Several students may work on a duplication of the same project. This helps to safeguard against individual failures.

For example, at the present time an embryological problem is being followed. The feeding and care of an animal colony devolves upon the teacher who is doing the research. A student who has had no previous experience with living animals expressed his desire to help with the colony so he could have some first hand knowledge of raising living organisms. Another student has helped in weighing and recording weights of animals. They enjoy the work because it is part of a serious investigation of scientific value. The abilities or knowledge of the student can withstand the small effort and the experience is stimulating. Another pair of students is engaged in raising worms to feed fishes which are to be used as part of another interesting investigation. A third student has expressed an interest in caring for the fish and checking the aquarium. Two students are doing a simple germination experiment, which requires regular examination of seed for evidences of sprouting and keeping records and dates. This experiment may have commercial possibilities.

These examples are sufficient. The faculty investigator is materially aided in the burden of routine details and not much time is required of the student who is volunteering his help. In some instances the student reads further into the subject and a new interest is born. He is also rewarded by the recognition of other students and the gratitude of the teacher. The project is part of something very much greater than itself.

Any teacher may find something in which students can be of help. It must, however, be within the limitations set by the students' knowledge, skill, age, experience, and abilities.

There are, of course, shortcomings in such a plan. Many problems cannot be broken into simple steps, cost of duplicating projects may be prohibitive, students can do only limited tasks in narrow areas. All duplicate projects could fail simultaneously, and considerable time is required to explain details of a task to each student although this has been avoided by instructing in one group the personnel of each project. Too, students cannot be relied upon, to interpret technical procedures involving a series of orderly steps which must follow in a fixed series, for great accuracy of measurement, for close weighing, or for chemi-

cal cleanliness. If one must supervise closely it is better to do the work in its entirety.

Conclusions

Student projects can be used advantageously to further research. This contribution is limited by the intellectual development and technical skill of the student, and is possible in several fields. Advantages of such a program followed consistently overbalance its disadvantages, especially if the reactions of the student are kept in mind. Administration and planning a program in which students are used requires thoughtful study as well as a suitable problem.

DUANE ROLLER RECEIVES OERSTED MEDAL

The American Association of Physics Teachers has announced that the Oersted Medal will be awarded to Duane Roller, Professor and Head of the Department of Physics of Wabash College, Crawfordsville, Indiana, at its next meeting. The award is made annually "for notable contributions to the teaching of physics."

Through the *American Journal of Physics*, which he has edited since it was founded in 1933, Dr. Roller had made probably the most notable contribution to the teaching of physics at the college and university levels since the subject was introduced into our educational system. If the JOURNAL were his sole contribution (which it is not) Dr. Rooler would richly deserve this signal honor.

Dr. Roller attended Culver Military Academy and did his undergraduate work at the University of Oklahoma. He also received the Master's degree at Oklahoma and taught there for thirteen years partly before and partly after his work for the Doctorate at California Institute of Technology, which he received in 1929. Subsequently he was a Research Associate at Columbia and an Associate Professor at Hunter College. During the first world war he was a pilot and during the recent war he was Chief Technical Aide of the National Defense Research Committee.

Former recipients of the Oersted Medal, which has been awarded every year since 1936, include W. S. Franklin of Lehigh, M.I.T., and Rollins; R. A. Millikan of Columbia, Chicago and Caltech; Henry Crew of Northwestern, and G. W. Stewart of Iowa. Last year's award was to R. L. Edwards of Miami University.

The formal award will be made at the January 31 session of the next annual meeting of the American Association of Physics Teachers, which will occur at Columbia University. In his address of acceptance Dr. Roller will discuss one of his chief professional interests, physical terminology, another field in which he has made notable contributions, both to the teaching of physics and to the science itself.

Cold storage box for airplane shipments is a four-foot cube insulated with fiber glass and cooled with dry ice. When containing six slabs of the solidified carbon dioxide, 10 inches square and one inch thick, the inside temperature is lowered 80 degrees Fahrenheit and held so for eight hours.

SCIENCE COUNSELING IN SECONDARY SCHOOLS[1]

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State departments of public instruction, universities, and teachers colleges are becoming increasingly concerned regarding the necessity for and the method of contributing to the improvement of instruction in the elementary and secondary schools. There has also been a growing realization that improvement of instruction can, in the final analysis, only result from activities which assist each individual teacher to grow in knowledge and improve in techniques. Consequently, state departments are, in many cases, coming to feel a responsibility for providing services which extend beyond regulatory and inspectorial activities by providing a counseling service which can aid the individual teacher.

Many of the states, if not all, have at present a program of general supervision administered by the state department of public instruction. The intent of this program is to see that basic standards are maintained in the schools; and where necessary the supervisors give suggestions for improvement either of administration, of instruction, or of the physical plant. Their counseling, however, takes on an administrative aspect, because the school which does not heed the advice of these supervisors may fail to be reaccredited. These officers are essential to the provision, within a state, of a school system with desirable uniformity of practices and equality of curriculum offering. But because of the inspectorial and regulatory duties of these supervisors, they can never work freely with the members of any school staff on a teacher-to-teacher basis.

Many states and many school systems, especially those in the larger cities, provide supervisors who are often vested with the authority to tell teachers how things are to be done in their system. Although it is true that the majority of supervisors use wisdom as they work with teachers and attempt to work on a counseling basis, it is also true that the teacher is aware of the

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[1] Walter Carnahan, Purdue University, Counselor for Mathematics in Indiana, cooperated in the preparation of this report.

This paper was read at AAAS meeting in Boston before a section sponsored by the Cooperative Committee on Science Teaching of the AAAS December 27, 1946.

fact that the supervisor holds authority vested in him by the superintendent. There is also evidence that some teachers have had unhappy experiences with supervisors which affect the basis for cooperation between teachers and supervisors in general.

Practically all of the states have federal grants under the Smith-Hughes and subsequent acts which provice for supervisors and itinerant teacher trainers in the distributive occupations, trade and industry, and vocational agriculture and home economics. Under this program the itinerant teacher trainers usually work as staff members of the state colleges and universities. They may at times be instructed to gather certain data, but they do not enforce any regulations. They are in the field to provide an educational service to the teacher, the supervisor, the school administrator, and the trustee or school board member. In the itinerant teacher trainer we have a close approach to the type of counselor service which is considered desirable, particularly when these teacher trainers are employed by the state universities or teachers colleges, rather than by the state department, who might impose administrative responsibilities upon them. We must keep in mind both the need for supervisors and the need for counselors who are free of administrative duties in order to maintain an effective relationship with teachers and administrators.

The particular type of counseling service described in the following remarks was developed to produce the most effective cooperation between the administrator, teacher, and counselor, and the teacher training institutions. This counselor provides the means for the interchange of ideas between teachers and also helps to coordinate and disseminate these ideas. This counselor, an experienced teacher, comes as a teacher, brings his own ideas and the ideas of other teachers, sees and discusses pertinent problems with the teacher on whom he is calling, leaves a new approach for this teacher, and takes away ideas to be coordinated and passed on to other teachers. He has no vested authority; he goes where and when he is needed, welcomed, and asked. He never tells anyone what to do, but he counsels with teachers and administrators in an effort to aid school personnel in arriving at a satisfactory and enlightened procedure.

In this particular type of advisory service the university is in a position to participate. The university, responsible as it is for using its special resources for educational purposes both on and off campus, and receiving as it does its students from the sec-

ondary schools, has ample reason to be interested in the provision of such a counseling service.

In Indiana the State Department of Public Instruction, the private and public universities, and the teachers colleges are cooperating to provide this type of advisory and counseling service. Indiana University pays the salary of a full-time counselor in social studies. Butler University provides a part-time counselor in social studies whose primary responsibility is to teachers who have graduated from Butler. The state teachers colleges provide counseling service particularly in the elementary field. Purdue University provides a part-time counselor in conservation and the biological sciences, another in the physical sciences and a full-time counselor in mathematics. The salaries of these counselors are paid by Purdue University, and in addition a special allocation of money is provided on a per diem and mileage basis to cover cost incurred in travel.

These counselors work in close relationship with the state department. Much correspondence relating to problems in the respective field of the counselor is forwarded to him for reply by the state superintendent; but his work is not dependent upon financial support provided by the state superintendent's office, which in Indiana might be irregular, due to the fact that the state superintendent is subject to popular election every two years.

Connecticut has one consultant in science and mathematics, who is attached to the Bureau of Youth Services and is on the staff of school consultants of the state department of education.[2]

New York State provides a science supervisor whose duties are:

1. To visit schools with respect to their administration and organization of the instructional program, particularly at the secondary school level.
2. To assist local school authorities in planning, organizing and administering the instructional program.
3. To prepare supervisory reports of survey character, including recommendations concerning the effective utilization of teaching and administrative personnel, relative to the educational program.
4. To speak at various educational meetings on topics of school administration and organization and to perform related work as required.
5. To make special investigations of research character relative to problems associated with the organization of the educational program.
6. To prepare bulletins, bibliographies, and other materials relating to general areas of responsibility in secondary school and administrative organization.

[2] Information obtained from survey conducted by the Cooperative Committee, November, 1946.

7. To evaluate and coordinate recommendations made by other responsible supervisors relating to the educational program.[3]

The state of Washington employs two counselors in science and mathematics. These people are on the staff of the school inspector, which seems to imply that they have regulatory as well as counseling duties.[4]

Doubtless there are other places where the type of counseling described in this paper exists, but inquiry failed to elicit any clear cut description of such services.

The specific services offered now in Indiana by the counselors in science and mathematics have been an out-growth of both the philosophy underlying the program and the experience gathered in its administration to date. Obviously, the time devoted to any one specific service varies with the nature of the activity and the current problems in the field of instruction.

The services offered at this time are summarized in the following paragraphs:

1. *Conferences with individual teachers* are often the result of an invitation extended the counselor by the teacher or extended indirectly by the school administrator. This type of work is considered the most important of all the duties of the counselor, for here he finds himself aiding directly in the improvement of instruction. The counselor and the teacher interchange ideas as teacher to teacher, in the hope that some idea may so stimulate the teacher as to bring about improved technique or greater breadth of understanding.

The counselor is often invited to teach a class for the teacher. Here he has an opportunity to demonstrate directly some of the procedures of which he speaks. Just as a demonstration in science is used to aid the student in the understanding of a concept, this teaching demonstration may be the best means for effecting a self-evaluation of methods and procedures on the part of the teacher.

The counselor often writes to teachers and school administrators to say that he will be in a certain geographical region during a certain week and therefore suggests the possibility of a visit. Sometimes the counselor makes an unscheduled stop at a school, and quite often these impromptu calls result in a most effective conference.

2. *Conferences with groups* are planned in advance and may

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[3] Francis T. Spaulding to K. Lark-Horovitz, December 5, 1946.

[4] Cooperative Committee survey, November, 1946.

consist of groups ranging from the teachers of a given subject from a single school to a group composed of those interested in a broad area of instruction gathered in a county or regional meeting. Problems discussed will vary from those specifically found in a subject to those common to all the teachers in the field. The counselor must be familiar with the problems of the area or school to be helpful, especially if the meeting is one of teachers of a city school system or of a single school. This involves background conferences with individual teachers, supervisors, and administrators to gain the necessary foundational information.

Recently the mathematics counselor was asked to make a study of the junior high school mathematics offering in the schools of an Indiana city of about 40,000 population. The counselor first conferred at length with the superintendent concerning the scope of the problem. Next he talked with the supervisor and finally with each teacher and the principal of each of the buildings. When the conference of all junior high school mathematics teachers was called, he was personally acquainted with each teacher and with the problems to be considered, from the point of view of both the administration and the teachers. He was able to lead the discussion and to intersperse ideas in such a way as to aid the group in formulating their own plans for improvement of the mathematics program. He had gone on invitation to bring ideas to this group but with no authority to dictate to them.

3. *Conferences with supervisors and administrators* are usually concerned with administrative problems, as for example, the total science offering provided in grades one through twelve of the school system. This would include a consideration of the elements of the offering to be required of all students and of the portions to be considered elective. Problems also evolve from the proposal to introduce new courses into the curriculum, the examination of existing courses to see how well they meet the needs of the student body, and the examination of the plant facilities provided for the teaching of each subject.

A school system in planning a new building may desire to avail itself of the experience of the counselor in setting up the specification for rooms, equipment and supplies for teaching.

4. *Individual and committee work on the preparation of curriculum materials* is one of the more important duties of the counselor. Work on the content and organization of subject

matter requires serious consideration of the usual existing procedure. The counselor and committee must remain sufficiently open-minded to break across the barriers of convention where this will facilitate a more effective organization and procedure. The result of such work is usually published by the state department in the form of bulletins which are distributed to all the schools. The Purdue counselors have participated in the development of bulletins in mathematics, physics, and conservation.

5. *The location and development of resource materials* involves both the development of new materials and the bringing of existing materials to the attention of teachers. The counselors attempt to be familiar with books which present teaching methods and techniques, technical information and related supplementary materials in the subject field, magazines and journals of interest to the teacher and those of interest to the student, visual aids appropriate for use in the teaching field, supplementary teaching materials available from private and industrial sources and government agencies, and apparatus and supplies usable in the teaching of the various subjects in the field.

The counselor in mathematics has aided the visual aids service of Indiana University to develop both lantern and film slides and to prepare boxes of demonstration materials for distribution. He carries with him an exhibit of selected teaching aids.

6. *In the encouragement of interest* in the field of specialization of the counselor, he often extends his services to lay as well as school groups. The counselor in mathematics gives demonstration lectures which are non-technical in nature and are directed toward the stimulation of interest in the study of mathematics.

The mathematics counselor has organized and participated in a series of radio broadcasts designed to go into the classrooms of Indiana schools. These broadcasts have aimed broadly at bringing supplementary materials to the classroom, stimulating interest in the field, and providing for a breadth of learning experience for the pupils in the high schools.

The counselors are active in state and national professional groups and encourage membership and participation on the part of teachers.

7. *The counselors conduct classes* in special methods, supervise practice teachers, and conduct workshops and conferences for teachers in service. In addition, the science counselor conducts

a class in physics methods and techniques, and the counselors attempt follow-up conferences with Purdue-trained teachers.

Experience with the program to date has indicated that services which can be rendered in this type of work are limited only by the time and imagination of the counselor. The constant evaluation of the effectiveness of different activities must be a part of a developing program, and this statement of current activities represents a stage in the evolution of the counseling program in Indiana. The next stage may be the provision of such counselors on a local or regional basis, supported by a program of federal aid. This would make possible a closer and more frequent contact with teachers than is now available.

THE VANISHING TEACHER

Teachers leaving the profession since 1939 have formed one of the greatest vocational migrations in our Nation's history.

The exodus has taken place in every state and territory, from every type of school, and from every field of teaching. In relation to their numbers more men than women have left the classrooms. Proportionately the loss to the profession has been greater in rural than in city schools, in elementary than in high schools or colleges, and in scientific or technical courses than in other studies.

The classrooms of the nation are normally staffed by about 900,000 teachers. A careful estimate places the number of experienced and trained teachers who have quit teaching entirely since 1939 at 350,000. Turnover in the teaching profession has been devastating since 1940. Many thousands of teaching positions were kept only open by the employment of three or four different persons in succession during a single year. Such instability of personnel would wreck a business or an industry. It has weakened school systems and impaired the educational opportunities of millions of children.

The number of teaching positions has been reduced, and an increasing amount of work has been divided among fewer teachers. Of the positions left vacant, approximately 60,000 have not been filled at all. Among those employed to fill positions, there were in January 1946, 109,000 emergency licensees who lacked the qualifications for standard teaching certificates in their respective states. One full school year has passed since V-J day. The number of emergency teachers has increased in that time by 29,000. The end of the war has brought no relief; the situation has become steadily more critical.

Qualitatively also the loss has been very serious. It is estimated that the average public-school teacher in 1945–46 has attended college one year less than the average teacher of 1939–40.

Mattress for hospital incubators is made of very fine fiber glass which does not stain, mildew, absorb moisture or retain odors. The fibers are resilient and do not pack down in use, and, being made of inorganic materials, contain no allergy-producing substances.

A LABORATORY EXPERIMENT ON OHM'S LAW ADAPTED TO THE TEACHING OF SCIENTIFIC METHOD

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Ohm's Law in the laboratory is usually presented as an experiment in the specific use of the law. Skill in electrical measurement and arrangement of instruments is a major aim of the experiment. However, with slight variation in approach, it is possible to bring out an important point in scientific method.

The pupils have previously learned how to apply Ohm's Law to a series circuit. They have also learned the relationship between watts, volts, and amperes. As part of the preparation for the laboratory the teacher assigns the following specific problem the day before the laboratory.

How much current will flow in a circuit with a 100 watt lamp and a 60 watt lamp in series on a 120 volt circuit? The objective in the laboratory the next day, is to connect the apparatus properly so as to verify the predicted amount as calculated by the pupils prior to the laboratory period. Brief discussion at the start of the laboratory period reveals that the majority have calculated the current as .31 ampere.

Using ammeters that can measure accurately to several hundredths of an ampere the class discovers that the current is appreciably greater than in all cases predicted. It is usually found to be about .40 ampere by most pupils in the class. The teacher can keep the pupils on their toes at this point by asking "How many have found that their prediction has been verified?" There will always be a few who will find agreement even though it does not exist, because they like to be on the winning side of every situation. This time those who have found a discrepancy between theory and practice are correct.

Since the great majority find this discrepancy and there is general agreement that the predicted current should be approximately .31 while it is actually .40 amperes, it is clear that the difference is not due to error on the part of individual pupils or to a defective meter. In fact the similarity of the discrepancy for all pupils rules out errors based on personal or instrumental deviations. What then is wrong?

The last thing in the world that the pupils think of is that there is something wrong here with the application of Ohm's

Law. They have seen it tested over and over again in classroom demonstration for both series and parallel circuits. However, in the previous classroom demonstrations of series circuits the teacher was careful to use small currents and telegraph sounders, instead of lamps.

The class is now divided into two groups. One group repeats the experiment with other bulbs (2–100 watt) in series. Another group tries the series measurement with two known resistors. Predictions work out properly and check with measurement in the case of the resistors. Those who have tried a new arrangement of bulbs find the same discrepancy as before. The actual current is universally greater than the predicted current when incandescent lamps are used.

Some of the pupils therefore conclude that there is something different about the bulbs that causes more current to flow. *The laboratory period ends without a satisfactory solution to the problem that has arisen.*

The next day some of the pupils come into class with definite hypotheses. Some have consulted older brothers or textbooks and have surmised that the lower temperature of the bulbs in series has reduced the resistance and has therefore increased the current. These pupils are challenged to devise an experiment to prove their point. (Up to this point, the effect of temperature upon resistance has not been discussed in class or assigned in their reading.) Discussion elicits the suggestion that we might try measuring the resistance of the bulbs *separately* when they are at lower voltage than the rated voltage and the filaments are therefore at lower temperature.

A circuit is then arranged with the lamp, a variable resistance, ammeter and voltmeter. By varying the resistance the current and voltage in the bulb can be changed and the resistance calculated from the measurement of the current and voltage. As the voltage and current (and temperature of filament) are reduced, the resistance calculated *decreases*, as they have suggested.

Thus, Ohm's Law in its simple form does not always work to perfection, as many pupils have been led to believe by the fact that it has always worked before in class. A new situation has arisen in which the application of Ohm's Law to a given circuit does not work. It is shown to be impossible with the knowledge they have to predict the current that will flow in a given lamp when the voltage is other than the *rated* voltage. Not until an

additional relationship has been established between the temperature and the resistance can Ohm's Law be used again.*

The lesson here is quite important. The pupils are shown that scientific laws are not necessarily inflexible and rigid. *Under new conditions they may not work at all,* and new rules, laws, and principles must be sought to enable us to use them. These laws and principles thus have definite *limitations* and the *conditions under which they operate must be specified.* Will Ohm's Law work for alternating current in the same manner as for DC current? Will it work at very high voltages? Will it work at very low voltages? Will it work at a temperature of absolute zero? Will it work for very large currents? For very small currents?

Nobody can predict with certainty until it is tried out by actual experiment just as we did in the laboratory. The rules that have been established as *Laws* must thus be used only in the areas in which they have been found to work. But the pupil should not be surprised if it does not work when it is used under some new condition. Numerous instances of this can be cited from the history of science.

This experiment thus gives pupils greater insight into the nature of a scientific law. It prevents illusions in the pupil's mind about the absolute rigidity of laws of science, which he frequently obtains from an intensive study of the manner in which laws work and can be applied. Somewhere in his study of these laws a good jolt like the experiment described is needed to keep him from falling into a rut. In other words the study of the conditions under which a law will *not* operate is an important part of the study of the scientific law. This will give the pupil that flexibility of approach and care in making unwarranted judgments and predictions that are such an integral part of the scientific method.

* Note: On a later day it may be well to try this experiment using carbon filament lamps instead of the tungsten. It may result in some student becoming interested in making a further study in the field of electro chemistry.—Ed.

HYBRID CORN POPS WELL

Popcorn sold by your favorite vender this year is more likely than ever before to be tender and tasty. Much of the present crop comes from the new high-yielding hybrid varieties of the yellow popcorn, developed by scientists of the Purdue University and Kansas Experiment Stations co-operating with the U. S. Department of Agriculture.

It is hard to distinguish hybrid from ordinary varieties in the unpopped grains, but when popped, hybrid popcorn expands about 25 per cent more than ordinary corn. The kernels are larger, almost hulless, tender and of good flavor. Few of the grains remain unpopped.

AN INTERESTING TREND IN THE TEACHING OF ALGEBRA

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There is today considerable interest being displayed in the introduction into the teaching of elementary algebra of considerations of its logical foundations and structure. The evidence for this lies in: the appearance of several periodical articles (1); the appearance of numerous general or survey mathematics texts (2), mostly on the junior college level, in which emphasis is placed on logical and philosophical questions as well as on broad surveys of mathematical subject matter and its connections with other sciences; the recommendations for such courses and texts made by the Joint Commission of the Mathematical Association of America and the National Council of Teachers of Mathematics (3) which several of the recent texts advertise they have followed; and, finally, the appearance of discussions of systems of postulates for number fields and ordinary algebra even in texts not intended to be of the "survey," "cultural" or "appreciation" type (4).

Historically this survey course trend may be regarded as stemming from the general mathematics movement growing out of the work and discussions of Klein, Perry, Nunn, Moore, Breslich, Karpinski, and others, but differing from many of them in both the grade level for which it is intended and the nature of its generalizations. From another viewpoint the discussion of logical concepts in elementary algebra may be regarded as the seeping down to lower levels of instruction of the concepts of modern abstract algebra which, though traceable to some extent to Galois and Abel in the first of the nineteenth century, nevertheless have had their greatest growth in the last seventy years, since Grassmann, W. R. Hamilton, and Cayley. A current motivation for such a trend may be found in a transfer to algebra of the modern emphasis on logic and the nature of proof in elementary geometry.

The problems to be solved by those interested in this trend are: a) to clarify the objectives of such instruction and to justify them fully in terms of the instructional time available and in relationship to the other aims of mathematical instruction; and to determine b) what is to be taught; c) how it can best be de-

veloped; d) at what grade levels this can be done most efficiently; and finally, e) to convince teachers that they should follow this trend and themselves take the time to do the necessary preliminary thinking and study.

The article entitled "Mathematicians Must Agree" by Paul R. Neureiter in the June, 1946 issue of SCHOOL SCIENCE AND MATHEMATICS performs the excellent services of calling attention to this trend and of inciting discussion of some of the problems it involves. This article, however, contains a few oversights and ambiguities which, if not corrected, may actually confuse both students and teachers rather than clarify for either the role of logic in algebra.

Mr. Neureiter in his article attempts to answer the question what is the meaning of $24 \div 3 \times 2$ by a "proof" based on a new "generalized commutative law." Actually, the best answer to this question is that it has no meaning at all, that it is ambiguous and therefore should never be asked or written. This is true because there is no generally accepted convention as to whether the division or the multiplication is to be performed first, as previously shown by Charles Salkind (5). Only a convention could give the question any meaning as the postulates for the field of rational numbers suffice only to show that $(24 \div 3) \times 2 \neq 24 \div (3 \times 2)$. Any such expression, then, should be written either with parentheses as above, or, still better, as a fraction.

Let's examine Mr. Neureiter's discussion a little more closely to see that his supposed proof is actually no more than a new convention.

His main argument was that: whereas $3-2 \neq 2-3$ and $3 \div 2 \neq 2 \div 3$, if we were for addition and subtraction to prefix "$0+$" to every problem and for multiplication and division to prefix "$1\times$" to every problem, then we could "commute" as much as we wished and always get the same answer, provided that with each pair of numbers or symbols interchanged, we also carried along the preceding symbols of operation. This is both ingenious and true, but subject to the following serious objections:

1) Mathematically, as stated, it is a misuse of the idea of commutativity. In defining a group with respect to an operation, one assumes a set of elements a, b, c, -, -, - and an operation indicated by $\circ$, such that for every pair of elements a and b there is a unique element c such that $a \circ b = c$. Such a group is termed commutative (or "abelian." after N. H. Abel (1802–1829)) if $a \circ b = b \circ a$. That is, commuting elements always leaves the operation and its symbol unchanged, interchanges only the particular elements of the set involved. Hence, the procedure suggested by Mr. Neureiter, as stated, should not be

termed a commutative principle, since it interchanges both elements and symbol of operation.

2) The reason that Mr. Neureiter's scheme works is that implicit in it is a new convention. This convention assigns to each subtrahend a negative sign to go with it wherever it goes and to each divisor a division sign to go with it. In addition and subtraction this is equivalent to changing the signs of subtrahends and then *adding everything*. In multiplication and division this is equivalent to changing all divisors to their reciprocals and then *multiplying everything*. Since addition and multiplication are each, by themselves, truly commutative, Mr. Neureiter's scheme gives the same answer irrespective of the order of the elements. Thus Mr. Neureiter's scheme implies that the value of $24 \div 3 \times 2$ is $24 \times (1/3) \times 2 = (1/3) \times 24 \times 2 = 24 \times 2 \times (1/3) = 16$, or, as he would write it, $1 \times 24 \div 3 \times 2 = 1 \div 3 \times 24 \times 2 = 1 \times 24 \times 2 \div 3 = 16$. Of course, were this convention (or any other) to be generally accepted, $24 \div 3 \times 2$ would no longer be ambiguous. No notion of proof is involved here, however, nor is any change in what is generally implied by a commutative law needed. Mr. Neureiter's scheme is merely a disguised convention which would operate perfectly under any of the accepted sets of postulates for algebra.

3) Pedagogically Mr. Neureiter's recommendations are unsound because they confuse that which teachers must struggle to clarify: namely, the double use of $+$ and $-$ as symbols of operation and as signs of numbers.

For these reasons I would conclude that the proposed "generalized commutative law" is not such at all, and if so treated would unnecessarily complicate and confuse the logical structure of algebra. The new *convention* implied in Mr. Neureiter's work would be all right if generally accepted, but since the ambiguity of $24 \div 3 \times 2$ is so easily avoided, as indicated earlier, a new convention hardly seems worthwhile.

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(1) See for example:

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———, "Mortar for the House of Algebra," *The Mathematics Teacher* 37: 206, May 1944

Northrup, E. P., "Mathematics in a Liberal Education," *The American Mathematical Monthly* 52: 132, March 1945

Stabler, E. R., "Demonstrative Algebra," *The Mathematics Teacher* 39: 205, October 1946

(2) For example:

Richardson, M., *Fundamentals of Mathematics*, The Macmillan Company, 1941

Cooley, H. R., Gans, D., Kline, M., Wahlert, D. E., *Introduction to Mathematics*, Houghton Mifflin, 1937

(3) These recommendations were contained in the Fifteenth Yearbook of the National Council of Teachers of Mathematics (1940) entitled ***The Place of Mathematics in Secondary Education.*** In particular, see Chapter VIII—Mathematics in the Junior College.

(4) See, for example, the Appendix to Miles, H. J.—*First Year of College Mathematics*, John Wiley and Sons, 1941, and the recent *College Algebra*, by A. A. Albert, McGraw-Hill, 1946. The latter develops the real number system more carefully and completely than is ordinarily done, but is much less complete then the former in its discussion of the postulates of algebra. The best discussions of these postulates for availability, compactness, and completeness are Miles' and that of Stabler cited in reference (1). Miles' postulates were drawn from a more technical article by Oystein Ore in the *Bulletin of the American Mathematical Society*, 37: 537–548, August 1931. An older and longer account than either of these is that of E. V. Huntington, "The Fundamental Propositions of Algebra" which appeared originally in *Monographs on Topics of Modern Mathematics* edited by J. W. A. Young and published by Longmans Green and Company in 1911, but which was reprinted in 1941 by The Galois Institute Press.

(5) Salkind, Charles—"Mathematicians Have Agreed," SCHOOL SCIENCE AND MATHEMATICS 45: 785, December 1945. Since the present article was written M. L. Hartung has also discussed this problem and pointed out a further error in Mr. Neureiter's reasoning in the article "The Order of Operations in Elementary Mathematics," SCHOOL SCIENCE AND MATHEMATICS 46: 752, November 1946.

RECIPROCATING PISTON MOTION CHANGED TO ROTARY MOTION WITHOUT CRANKSHAFT

The familiar crankshaft of the ordinary engine may soon be replaced by a new motion transformer that converts the back-and-forward movement of the piston into rotary motion without connecting rods, wrist-pins and crankshaft.

The device can be used also to transform rotary motion into reciprocating motion when needed, in pumping operations for example.

It is an invention of James A. Hardman, Logan, Utah, and has now been tested at the National Bureau of Standards where it is pronounced practical.

The heart of the new device is a short rod, called a yoke, attached to and at right angles with the piston shaft. It moves forward and back with the piston, and is also free to rotate on the shaft. Each end of the yoke is inserted in a ball bearing mounted in a socket on the flange of one of two wheels or rotors within the housing holding the yoke.

These rotors are positioned parallel to the reciprocating rod and equal distance from it. As the rod moves back and forth in simple harmonic motion, the yoke moves with it and the balls in which the yoke ends are inserted, and the rotors in which they are mounted, rotate in opposite directions.

In the movement the yoke necessarily tilts. Since the distance from the center of the yoke to the rotors varies with this tilting, provision is made so that the yoke can slide through the spherical bearing. A fly wheel on the shaft of each rotor smooths out the rotation and carries the yoke and rod past the dead center positions.

PEOPLE IN THE OUT-OF-DOORS*

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There were two by-products of the wartime Victory Garden campaign which were more important than the vegetables raised. Thousands of city people learned first-hand about soil and how it produces. The other by-product was the engendering of neighborliness—friendliness—among people of the same block or the same community.

City people live in a black fog of intolerance: intolerance of the Gentile for the Jew; intolerance of the white man for the colored; intolerance of labor toward capital; intolerance of him that hath not toward him that hath, and vice versa. If they happen to escape from the city's "rectangular symphony," the cacophony of the city block, they are intolerant of things in nature because they have no roots and no kinship with the land. Further, there is mounting organized antagonism between the urban-industrial worker on one hand and the rural and the small-town agricultural workers on the other: suicidal folly which can wreck our social-economic structure and the foundation upon which this nation rests.

According to the 1940 census, 56.5% of our population is urban and 85% of that urban population lives in 140 metropolitan centers like New York, Chicago, Detroit and San Francisco. Scratch the callus created by what Lewis Mumford called "a life of highly organized discomfort" and, behind the opulent surface, you find square mile after square mile of festering slums and the dreary monotony of hopeless struggle. There you find thousands of youngsters who have never seen a field of wheat or corn; who believe milk comes from bottles and bread from a store; who have never seen an animal other than the cat, the dog, the sparrow and the alley rat. Those youngsters grow up to vote as their parents vote: they vote as they are instructed by precinct captains or according to what they read in some newspapers.

Our basic problems of land-use are involved. Most of our ills are problems of improper land use. Misuse, destruction and

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* Presented before the Central Association of Science and Mathematics Teachers at Detroit, Michigan, November 30, 1946.

waste stem from intolerance; intolerance stems from ignorance. The cure for ignorance is education.

Can we plant in city people the ideals of "Georgie the Wash," "Tommie the Jeff" and "Abie the Link?" Can we bring them to an understanding of what made and keeps this country great? Can we teach them the unity of nature in simple terms of man's existence in relation to soil, water, vegetation, minerals and animal life? Can we teach them why conservation of natural resources is a fundamental prerequisite for national welfare? Can we teach them to vote intelligently on questions related to the wise use, appropriate protection and desirable development of our natural resources, be those resources human, animal, plant or mineral? I think we can.

The late Dr. Henry Baldwin Ward stated my case: "The little red schoolhouse and our national system of public education which has grown out of it are still, with all their defects, our most far-reaching and most potent means of developing public opinion," as well as the greatest conditioners of social conduct.

I am an engineer and a would-be naturalist. I am not an educator. But I humbly state that I subscribe to Dr. Ward's pet theme: *one* defect in our educational system is that between things as they exist in nature, and natural science or the biological sciences as they are taught in the classrooms of most elementary schools and high schools, there is a wide gap which should and can be bridged. Too frequently, the teaching is from books and specimens by teachers with little intimate knowledge of nature lore or of the land itself. Even where the teacher has adequate training and outdoor experience there is no opportunity, particularly in city schools, to take pupils on field trips that will tie together what they have studied with things as they exist. In most rural schools, where there is opportunity, it is ignored. Biology must be taught as a fundamental all-important cultural subject: a fascinating dramatic story of all life, accompanied by rich experiences out-of-doors; not as an elective; not as a terrifying maze of scientific names and anatomical structures.

I believe that emotional experiences out-of-doors will bridge that wide gap, and that they are essential for the elementary school pupil. Once you activate the bump of curiosity characteristic of the child, he is likely to forge ahead under his own steam. A youngster can learn and have fun doing it. And we

have found that nature appreciation engendered by nature lore acquired first-hand is the key to the door opening upon a concept of the broad field of conservation and its several phases. That concept is essential to good citizenship and wise use of our natural resources. An intangible by-product for the individual will be a fuller richer life.

Chicago is peculiarly fortunate among all of our great cities. Cook County, which contains Chicago and 93 of its suburbs, has a Forest Preserve District which girdles it with green. Our holdings now total 37,000 acres—the state park system of Illinois totals 25,000 acres—distributed throughout this county of 4 million people. Sixty percent of it is forested; eighty percent of it is wild land. It is not a park. It has different peculiar functions. Its charter mandates the commissioners to restore, restock, protect and preserve these lands, together with their flora, fauna and scenic beauties, in their natural state and condition as nearly as may be, for the education, recreation and enjoyment of the people.

It has been necessary to provide 165 picnic centers for intensive use, but they are located on the fringes. The interiors, the bulk of the holdings, are accessible only by the 175 miles of constructed trails or by walking in from the highway borders. In effect we have 37,000 acres of sanctuary with wildlife populations notable for their diversity and density.

The preserves are used by some 15 million visitors per year. The bulk of these people use it only for picnicking, swimming and golfing. On the 17 Sundays and holidays from Memorial Day to Labor Day they come out to eat, drink, dance, play games, and go home at sundown no wiser than when they came. Some come to bask in the sun or lie in the shade. Few venture into the interiors. They are afraid—literally afraid. Great masses of the American people do not know how to enjoy themselves out-of-doors. They are strangers there. Unintelligent use and failure to use mean that the people are not enjoying what they pay for. More serious is the *misuse* of those properties and the recreational facilities. Careless destruction, fires and vandalism have become major problems. More than half of our time and money is spent in trying to protect what we've got.

During my 13 years as Superintendent of Maintenance, we came to realize that there had to be an attack upon the problems of maintenance and protection at their source; that, fundamentally, our job was one of improving the quality of public

use. Aldo Leopold handed us that phrase. As trustees of public property, the problem of every park and forest man in the country is to teach people how to properly use and enjoy their own property. We must get them out on their feet, walking. We must *entice* them to look at nature. We must make them tolerant and friendly toward the trees, the wildflowers and the wild creatures. We must teach them *perception*. We must support and participate in every program to promote the education of all the people, at all age levels, in conservation and resource use.

I was spending so much of my time on "extracurricular activities" that on January 1, 1945, my boss created the Department of Conservation of which I am Superintendent. Its major function is education. Fundamentally that means nature appreciation, based upon the concept that appreciation will beget tolerance, tolerance will beget friendliness and friendliness will beget wise use. We aim to make every man, woman and child feel at home in the out-of-doors and recognize that everything there, animate or inanimate, has a place and a function deserving of respect.

Nature Bulletins

One successful medium employed has been our weekly nature bulletins designed for classroom use and for newspaper publication. Each deals with some animal or plant, some group, or some condition in nature, that can be seen at that particular time. Each is designed to stimulate the reader's curiosity, at the same time subtly emphasizing the subject's ecology, its right to exist, and its relationship to man and the world about him. They have ranged from fireflies to snowflakes; from snakes to wildflowers; from thunderstorms to katydids.

Each bulletin has a core of factual information known usually to comparatively few wildlife observers and scientists; rather than information readily available in textbooks and encyclopedias. Each is limited to one typewritten page, double-spaced. Otherwise newspaper editors throw them in the waste basket. They go to 135 newspapers, including the big Chicago dailies, 48 foreign language papers, the Chicago community papers, and all the suburban papers. Many papers print them every week; others only occasionally. Columnists on the big dailies print portions and comment on those that capture their fancy. To intrigue these gentlemen we usually add a tag-line. For instance:

The bulletin about lady-bugs ended: "The male lady-bug is called just that."

The one about fresh-water mussels ended: "There are two sexes but the difference is important only to another clam."

The one that first put us on the editorial map was the bulletin about fireflies. Discussing the 96% efficiency of the insect's tail-light and its function in attracting males to females, it wound up with the tag-line: "That 96% efficiency was made for love." That made Page One. Of course, in the summer time when the bulletins go only to the newspapers, we have a little more leeway with that tag-line.

We are nearing the point where every school in Chicago and in Cook County outside Chicago, both public and parochial, both elementary and secondary, receives an adequate number of each bulletin. Our weekly distribution now exceeds 5300 copies and will jump to 6300 because I discovered that only three copies reached each of the 330 elementary schools in Chicago.

Last week, at the request of the State Superintendent of Public Instruction, we added to our mailing list each of the several teacher-training institution in Illinois and each of the 102 county superintendents of schools, authorizing them to reproduce these bulletins for their own distribution. The mounting demand from outside the state, and for the back issues, will be met shortly when Didier, of New York, publishes them in illustrated book form to be sold at nominal cost.

Nature Trails

To entice picnickers to walk and learn a little about the adjacent woodlands, last summer we experimented with short nature trails in some of the major picnic centers. Our experience in attempting to maintain a nature trail in connection with our Trailside Museum, demonstrated that attractive substantial labels quickly disappeared or were mutilated. Accidentally we discovered that the labels used to mark a temporary nature trail in one of our picnic centers, intended only for use in a two-day training course for Boy Scout area executives, remained undisturbed for three weeks These labels consisted of white 3″×4″ cards of a good grade of heavy stock, or of cloth shipping tags. They were tacked on trees, attached by fine wires to shrubs and weeds, or tacked on stakes driven beside wildflowers and low-growing plants such as grasses, wild strawberry and

cinquefoil. Lettered by hand on each, with a soft "copy" pencil, was the common name of the object and some significant information about it.

Large numbers of people followed these trails, idling along, commenting on the labelled species. Our naturalists *snuck* around and kibitzed, incognito. At the close of the season we found that in 11 areas where there had been no maintenance of the labels, the percentage still in place and usable varied from 2.1 to 83.2, with an average of 39.7%. Apparently, in certain areas it may be impracticable to maintain this type of nature trail, but we propose to install them in all of our major picnic centers, giving them periodic inspection and replacement. The length of each will be 300 to 500 feet; the number of labels per trail will vary from 50 to 75. The only explanation for the comparative success of this type of label seems to be that they are just too cheap to bother with.

Lectures to School Assemblies

We have one naturalist with the gift of handling and talking to kids, who travels about giving illustrated lectures to assemblies in the suburban and rural schools. His 40-minute talks about the forest preserves, how to behave in them, and the wildlife there, vary with the age level. To the teachers of the lower elementary grades he gives mimeographed copies of a story to be distributed. Since January 1 of this year he has talked to 53,251 children in 166 schools.

We are building up a library of moving pictures in color with sound, and of Kodachrome slides with accompanying sound records, because the demand for this man's time far exceeds the supply. The Chicago schools are requesting similar programs. Apparently we will have to increase our staff.

Day Camps

Last summer one of the big Jewish community centers in Chicago, operating six large day camps for children, sent those camps to six of our picnic centers on one day each week for eight weeks. On the other four days per week they utilized their community center or the Chicago parks. We have been urging youth organizations and welfare centers to do this. Some of the Girl Scouts had done so.

Our 165 picnic centers are virtually empty on week days. Allowing Mondays for cleaning up the welter of garbage and

trash from the Sunday picnics, there are four days of each week when they are ideal for day camps. All the necessary facilities are there. Just outside the mowed picnic grounds are the wild unspoiled woodlands, meadows and stream banks for hiking and nature study. Healthful, enjoyable and educational outdoor experience, at a minimum of cost, could be provided for thousands of youngsters who crave it but will not get it otherwise. There are not, nor will there ever be, facilities for overnight camping in the Chicago region for more than a small fraction of its youth.

The director of one of these six day camps holds a doctor's degree in zoology. She asked us to assist her in conducting a nature program. Each Wednesday, for eight weeks, 125 children of both sexes, from 5 to 11 years old, came out in buses and spent the day in one of our picnic centers. Our Senior Naturalist and an assistant spent the day with them, taking successive groups of 25 on 45-minute field trips along a labeled nature trail, concluding with a general session or "council ring" where a segment of a connected story of the Chicago region, from the early geologic ages until now, was related.

On the first day, most of those children and some of the counselors were afraid to sit on the ground—because of ants! They asked what those things were, hanging on a tree, that looked like pumpkins. They had never seen a hickory nut, nor an acorn. The trail led through a patch of giant ragweed in the river bottom and they thought they were in darkest Africa. By the end of the summer every child was collecting, handling and identifying insects, frogs, snakes, mice, leaves, weeds and knew all the common trees. During the lunch period on the last day, they came running up to us in a continual stream, with everything imaginable, jubilantly displaying a "find" or with questions tumbling out of their mouths. They had lost all fear and they jealously regarded that area as "their preserve."

Experimental Field Trips

On March 10, 1945, we initiated an experiment consisting of a series of field trips for selected groups of school children, conducted on Saturdays by our staff of naturalists. Every other Saturday we took out 14 sixth-grade pupils from a suburban school in a community predominately Italian. On alternate Saturdays we took 15 pupils from the biology club of a large suburban high school in a community noted for its wealth and

conservatism. On Wednesday mornings, during school hours, we took out 15 sixth-grade pupils from a different suburban school. These trips continued until the close of school in June.

During the entire school year of 1945–46, every other Saturday we took out a new group of 26 sixth-grade pupils from the school in the Italian community. We had found that after the first trip we could handle 25 or 30 as easily as 15. Any youngster that did not keep with the group, or did not keep quiet and pay attention when we were explaining something, was asked if he wanted to come again or stay home. That worked. This group continued during the entire nine months. On alternate Saturdays the group consisted of 25 to 30 Negro pupils from a big high school on Chicago's South Side. At the beginning of the second semester, at the principal's request, we took a new group of 25 Negro pupils. No teacher accompanied the sixth-grade groups—much to our disappointment—but from one to four biology teachers accompanied the high school groups on every trip, purely as observers.

The groups were "selected" in that approximately equal numbers of boys and girls were enrolled, parental consent was required, and included were a few individuals known to be unsocial or maladjusted, and lacking desirable aptitude or attitude in their school work. The high school groups were similarly selected from the several biology classes in each school.

A large covered truck was used for transportation from the school or—in the case of the Chicago pupils—from a street car terminus. We now have our own bus for such purposes. Each trip was different, suited to the season and the weather on that particular day. Even on bad days they spent much of the time out-of-doors in short intervals.

In March we took them to a big slough when the ice was breaking up. They observed the turtles emerging from hibernation and the dissections of one big snapper; spring peeper and cricket frogs; crayfish carrying young; migrating ducks and geese; the first aquatic insects; the first plants, snakes and songbirds; animal tracks along the shore.

In April we visited our Forest Preserve hardwood nursery and they learned how to propagate and transplant young trees and shrubs. One trip was made to a commercial limestone quarry rich in fossils, including coral. Another took them to a large farm where they saw all the common farm animals, implements, practices and crops. For most of them this was unique experi-

ence. They fished at one of our lakes with crude poles and, after they had learned to identify the fish they caught and what we caught in nets, we cleaned and fried those fish for them to eat. We had them turn over and tear apart rotting logs; count the visible living things in a cubic foot of soil; identify and weigh, by genera, the plants growing on a square yard of meadow. On each trip, as they went along, they learned to identify the common trees, wildflowers, weeds, grasses, birds, mammals, reptiles, amphibians, soil types and cloud formations. Ecological relationships were stressed. Intimate unforgettable details in the life histories of certain species were pointed out.

They were taught to fear nothing, including snakes, and to handle snakes, as well as worms, mice, fish and insects. They were taught to see the beauty in the jewelled eye of a toad. They were given old coffee jars and allowed to take home live snakes, frogs, turtles, mice, minnows, old bird's nests, insects and skeletons. The groups reported back to their respective classes what they saw on each trip and exhibited their collections. But they were not graded. Nor were they required to keep notebooks—although many did so. Above all they had *fun*.

Of the 14 sixth-grade pupils in the 1945 spring group, nine improved their general scholastic standing, three showed no change, and two showed a slight deficiency. But none of them failed in any subject although several possessed below-average I.Q.'s.

The principal of this school writes us as follows:

"We are very sorry that these tours cannot be continued this year, for the school's educational curriculum had been greatly enriched and the beneficial effects on individual students have been very noticeable.

"Nearly all the pupils participating in these science excursions have shown a greater interest in scientific and educational reading. They have become the leaders in such organizations as the School Library Staff, the Safety Patrol, and the Boy Scouts. Last year 19 of the 26 pupils raised their scholarship standing while participating in the tours. Although we had 27 yearly failures in our school last year, there were none in the sixth grade.

"Such a program would be valuable for my school in building higher scholarship, better citizenship, and a greater interest in science and nature study."

The results of these trips with high school groups were not as tangible. Statistical analysis showed no correlation between their grades, even in biology, and attendance on these trips. Yet every biology teacher from whose classes students were selected to take the trips, has been emphatic in assigning in-

tangible benefits to the classes as a whole and to most individuals. One of them writes, in part, as follows:

"I don't think the marks tell the whole story, however. In general, I should say that the trips made the students more alert and aware of their surroundings, increased their self-confidence and broadened their interests. In my class that had five of the students taking the trips, there was a lively interest in biology because of the reports made about the trips and the material brought back. Interest was stimulated in the library—in books on animals and plants.

"These boys and girls are very underprivileged, of course, as is summed up in the statement of James Miller that the only animals he had really known were the cat and the dog (and, I may add, the alley rat)."

This lady and her colleagues cited many specific cases of individual improvement. I have quite a file of reports from these teachers and of letters voluntarily written by many of those Negro students. They are illuminating.

One boy spent extra time in the biology laboratory and plans to major in forestry as a result of these trips.

Another, a very bright student but not aggressive, made outstanding reports to the class on these field trips, did much outside reading, is going on with a science sequence, and plans to study medicine.

One girl, a problem case who had never been interested in anything but mischief, was enthusiastic about the trips from the start and her enthusiasm carried over into other subjects. This year she is doing excellent work.

Another girl, unusually squeamish and timid, finished the semester with a painted turtle for a pet. She also learned punctuality because she missed the group one Saturday. Two other girls, also unusually squeamish, learned to handle snakes, frogs, worms, bugs and fish—which they had always feared or detested. Another developed an interest in the world of plants.

Another boy brought a failure grade up to passing and was stimulated to make independent collections of leaves, fruits and fungi.

On the other hand, there were a few who went along just for the buggy ride and, until the end, regarded the trips only as enjoyable outings. The grades in biology of several declined a notch, either during or after their participation in these field trips.

There are insufficient data for more than this general statement: "The more underprivileged the child the greater the need, the interest and the response."

Tentatively, however, I would add:

(a) For the lone wolf, the maladjusted child and the problem child, such trips are likely to be a godsend.

(b) The beneficial effects are quantitatively measurable among grade school children but not among high school children.

(c) In certain individuals among high school groups such trips may have a determining influence upon their future.

(d) Such trips, for groups of 25 to 30, should start with the sixth grade—no younger.

(e) Grade school children are easier to handle than high school children. Their interests are more unilateral. There is less by-play between the sexes in a mixed group. In a high school group of both sexes there should be one or more teachers present.

Conclusions

These field trips were experimental, intended to demonstrate that they are desirable as an integral part of the school curriculum provided that they are conducted by teachers who know their way around in the out-of-doors, and who have not only formal education in biology but also adequate training in field trip techniques. Obviously the conduct of such field trips in a metropolitan region is beyond the capacities of recreational areas such as our Forest Preserve District, and must be a function of the schools themselves.

We recognize that there are many practical difficulties attending the conduct of such trips as part of the school curriculum; including the difficult adjustments of class schedules if they are to be taken during school hours—and that is essential; the provision of transportation; and the responsibility for accidents. We don't pretend to know the answers. But I hope to see the day when at least four such trips per year are held for every pupil in the 6th, 7th and 8th grades, and for every student in the biology classes of the high schools. If that ever happens, after two years there won't be a snake or a last year's bird nest left in Cook County!

The problem is to "sell" the idea to educators and school boards. The principal bottleneck is and will be: *teachers*. Let's face the fact that some teachers are congenitally unfitted for field trip leadership. For those who do the job there must be devised, provided and required in-service and pre-service training. In-service training in the form of workshops, including summer conservation laboratories, is being variously given in Maine, New Hampshire, Massachusetts, Connecticut, Rhode

Island, New Jersey, Pennsylvania, Ohio, Indiana, Virginia and some of the southern states. The University of Illinois, in conjunction with the five state normals, is planning a summer conservation camp downstate in 1947 and a second one in the Chicago area if and when we make the site available. But you can bet your bottom dollar on one thing: workshops and summer camps are not and will not be successful unless substantial college credits are awarded the teachers enrolled. It took me a while to learn that.

The University of Illinois and the five normals conducted one-week extension courses in conservation in 19 counties this past summer. The teachers, largely rural, received one hour of credit. The enrollment was only fair. Next summer, two-week courses with two hours of credit will be held in a greater number of counties.

I have proposed to these institutions that we of the Forest Preserve District shall conduct a series of field trips for elementary school teachers in Cook County, each spring and fall, for which each participant fulfilling the requirements would receive one hour of college credit. We could take one group of 30, every other Saturday, on four trips in the fall; on alternate Saturdays we could take another group. In the spring we could train two different groups. If warranted by the demand we can buy another bus and increase our staff. Why not?

I hope you don't low-rate me as just another rambunctious meddling fanatic. I keep thinking about those 125 Jewish kids in that day camp. But I'm humble. After handling millions of people for 13 years I've learned many things in the past two years from the teachers and school administrators with whom we've worked. I hope to learn much more.

The other day I saw a show-window poster which read: "Every individual who has ambitions to contribute to our economic and cultural civilization must strive to be a philosopher." I got out my two-dollar dictionary. I found that a philosopher, among other things, is one who schools himself to calmness and patience under all circumstances.

Plastic-coated steel pipe, developed for oil-well drilling to protect the tubing from corrosion, are usable in other industries. The coating is impervious to oil and water, withstands high temperature, and resists mild chemical attack.

SOCIAL IMPLICATIONS OF THE POWER AGE*

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NEED FOR BETTER EDUCATION

My thesis is that the social implications of the power age indicate that we need more and better education in the natural sciences, social science, and the humanities. Unfortunately, for the most part, we do not realize that the power age has great social implications. We seem to think that everything will come out all right, that someone else will solve the problem, or that we are doomed anyway. We appear not to be interested in a serious study of social problems. The common idea is that social scientists have nothing to contribute, that needed social inventions will automatically come about, and that our future citizens will somehow absorb social intelligence through a process of osmosis while growing up. It is thought by some that any fool can teach social science and that no special training is needed. Moreover, it is felt that serious analysis of the problems of labor or race or peace is dangerous. Apparently, we believe that social myths, superstitions, the propaganda of special interests, and the beliefs in encrusted tradition are better than professional thought on social problems.

BETTER SOCIAL EDUCATION

Unless we develop social scientists and social technologists, and an intelligent world citizenry with a sense of integrity, the outlook is, indeed, black. A large share of the responsibility belongs to educators in every field. All of us should be concerned, as it is obvious that no scientist or true scholar can flourish unless he is free to do research and is assured of reasonable security. Our future depends on the solution of our social problems. We must work together on these most difficult and important problems of social relationships.

Some of you may object to the term "social science." Many persons, especially natural scientists, do not believe that psychology, anthropology, sociology, government, economics, or history can be scientific. Nor do they believe that human rela-

* Read at the Junior College Group Meeting. Central Association of Science and Mathematics Convention. Detroit, Michigan, November 30, 1946.

tions is a proper subject for scientific research. It is certainly true that the observational sciences of astronomy, geology, and systematic biology, and the experimental sciences of physics, chemistry, and experimental biology have made more impressive advances than have been made in the social fields—advances that can be strikingly presented and often put to immediate use.

However, it seems to me that the scientific method has proved so effective in dealing with nature that we should attempt to make use of it in dealing with social problems. Surely we should try to seek the pristine truth without prejudice, passion, or resentment (that is, without prejudgement) and with impartiality, realizing the importance of tolerance in evaluating arguments objectively. It seems to me that a basic condition of good citizenship is that we free ourselves from individual bias in judging social issues. We must use the scientific method, which means an exact and impartial analysis with the elimination of emotional reaction and the avoidance of hysteria and sentimentalism. We must apply rational methods to the study of human problems as laboratory technicians analyze smears and specimens or a geologist studies rocks.

Naturally, we know perfectly well that we cannot solve social problems in a chemical laboratory; nor can we treat human beings as numbers or as chemical elements. A new tax theorem cannot be tested in a laboratory. The social studies cannot become an experimental science on a large scale. Perhaps more can be expected from copying the observational sciences. Even then it is most difficult to rid ourselves of biases and be objective—about teachers' salaries, for example. But if we expect to solve our pressing social problems we must try to get the relevant facts and analyze them objectively, laying aside our preconceived notions and ideas. We must recognize our prejudices for what they are and make every effort to exclude them.

Obviously, this is difficult. It is not part of my thesis that social studies are simple. Certainly a study of the structure and functions of society, and the forces which operate upon them is most complicated and difficult. I also admit that we know too little about these things. But I believe that we shall learn more only if we use the scientific method. It seems to be the belief of some that a scientific analysis of social problems is an irridescent dream. In this present age—perhaps the most dangerous since the fall of Rome—can we permit such disillusionment, such a

mood of defeatism? Social science must no longer be a *terra incognita*.

However, useful as it is and much as we need it, the scientific method alone is not sufficient, in my opinion. We need ethical concepts. We must teach our students a standard of conduct: the difference between right and wrong, good and evil. We must emphasize ideas of honor, integrity and morality, particularly since we have been brutalized by a war fought with no holds barred. Our social well-being, our very existence, depends upon higher personal and social ethics.

Now I know that the above statements may seem to contradict what I have said about science, and that my colleagues who swear by pure social science would disagree with me. I realize that in pure social theory for advanced students the manner in which forces work under given conditions should be separated from the way they ought to work, and it should be made perfectly clear that a scientist tells us what may happen under given conditions, and not what ought to happen—that is the business of ethics. Unfortunately, some scientists confuse ethics and science and do not think objectively when they are outside their own fields. I have heard physical scientists who are most objective while in their laboratories express the most prejudiced and unscientific views on what should be done about racial minorities, labor unions, and social security. Perhaps that is only further proof that teaching ethics to voters is of vital importance, although we must separate pure social science from social ethics. After all, democracy is an ethical concept, and if you are going to teach citizenship you are teaching ethics. You may say that it is unscientific or that ethics belong in the church. But I firmly believe that teachers on the junior college level must be interested in both the scientific and moral aspects of social problems.

The Interest of Scientists on Social Problems

Indeed, one of most thrilling events of the past year is the interest physical scientists have shown in social ethics and social problems. As far as I know scientists have never before shown such concern for social and political issues. I am speaking particularly of the atomic scientists. In fact it has been said that nuclear physicists are now giving one of the most unusual instances of mass horrification in world history. Nobel Prize winners, including Arthur Compton, Neils Bohr, Irving Langmuir,

and Albert Einstein, have written on the social implications of the power age. Dr. J. Robert Oppenheimer, Professor of Physics at the University of California, was a co-author of the Lilienthal Report. (See "A Report on the International Control of Atomic Energy.")

Not only have scientists done hard thinking and excellent writing about the social implications of the atomic bomb, but they have also formed organizations to lobby in Congress. The Federation of American (Atomic) Scientists is an organization of scientific men who are no longer cloistered scholars interested in a narrow specialty, but men with social vision. The new Federation of American Scientists, which includes not only atomic scientists but also radar and rocket experts and others, is applying its energies to social and political problems. It is wonderful to know that our most distinguished natural scientists are now realizing the social importance of their work. Scientists were, in great part, responsible for the defeat of the May-Johnson bill which emphasized military control of atomic research.

Science Now Shoulders Great Responsibility

These activities should help to lessen the gap which we must bridge between the emphasis on natural science and social science, between our horse and buggy social institutions and the spectacularly speeding physical and biological world. We seem to be facing an atomic revolution alongside of which the so-called Industrial Revolution will be considered of secondary importance. Great advances in science and technology always precipitate social changes, and every discovery brings new social problems. I believe Dr. Hutchins of the University of Chicago has said, perhaps with but little exaggeration, that the world has apparently arrived at the height of its information, technology, and power over nature, and, at the same time, has reached the extreme depth of moral and political life. If our civilization is to survive, obviously we must eliminate these lags. It is an ironic but true statement that man, as a result of scientific advances, finds himself pitted against his fellow men in a struggle which threatens even his own technological improvements.

Perhaps, as H. G. Wells prophesied, the "cosmic episode" is about to close and the world and all its inhabitants will disintegrate. Is the world writhing in its death agonies? Are our social problems beyond the capacity of human ingenuity? Do we lack

the will and the ability to discover, to invent and adopt social institutions which will bring us peace and prosperity, freedom and security? Indeed, survival will be difficult if we do not solve the fundamental problems of human relations—if we lack the social intelligence to eliminate violence as a method of settling disputes. This is the task, not only for social theorists and social technologists, but for all of us.

Some have suggested that we put a moratorium on scientific development until the lag in the field of social thought is cut down or eliminated. It has been urged that we concentrate our energies on social studies rather than the natural sciences so that the social improvements so much needed can be brought about. While I believe there is an element of truth in this, for certainly the gap is real and terrifying, we need to extend our energies in all fields, in the physical as well as the social sciences in order that we may benefit from the constructive discoveries being made.

However, it should be clear that the social lag is particularly dangerous to the natural sciences since science and technology have found destruction easier than construction. Although science is riding high, and its prestige is tremendous, science may be blamed if there is a third world war. It will do no good to say that scientists are neutral, that they merely seek the truth. The people will blame the scientists and seek other idols. There is something in Thomas Jefferson's letter to John Adams written in 1812: "If science produces no better fruits than tyranny, rapine, and destruction of national morality, I would rather wish our country to be ignorant, honest, and estimable, as our neighboring savages are." It is possible that the slogan will be: "The Republic has no use for scientists," once used by the Jacobins at the trail of A. L. Lavoisier before the Revolutionary Tribunal at Paris in 1794.

The great scientist, Dr. Harold C. Urey, has said this more effectively in his article: "Technology: Peace or War" in the October issue of *Social Science:* Dr. Urey points out that while the scientists can truthfully say that they intended to bring a richer and fuller life to mankind, that they had no intention of creating destruction and misery, the hard facts are here, that another war will destroy civilization. He adds that while the problem is one of social organization and not physical science, the scientists cannot be unconcerned, but owe all the help they can give to the solution, for they are first citizens and second

scientists and engineers. He reminds us that science depends on free discussion and publication.[1]

Proper Education Our Only Hope

I believe that man has the ability and the willingness to control the forces which he has set in motion if he will make use of the scientific method in social thought and through a standard of ethics. The only hope we have is that through reason and good will our problems are solvable and that we will solve them.

We can solve the problems of human relations, including international relations, race relations, labor relations—even, perhaps, marital relations. We can bring about peace and prosperity. We can live in this highly integrated world, if we use not only our minds but our consciences as well, if we apply science and ethics, not science alone. Of course, we will have to crack the nut of national sovereignty. We must realize that we live in one world. It may be more difficult than convincing people that this is a heliocentric, not a geocentric universe—and perhaps some modern Galileos will have to suffer for it, but it must be done.

National sovereignty must be limited. Arthur Compton has said that we must choose between adjusting the pattern of our society so that wars cannot occur, or continuing the obsolete pattern of national defense which will result in disastrous conflict.[2] Yet to give up national sovereignty will not be easy. Social theorists and social technologists must learn how world sovereignty can be established, and the peoples of the world must be given the facts concerning the immediate and long run effects of absolute sovereignty and limited sovereignty so that they may make a wise choice. Certainly scientists, whose work makes international collaboration a necessity, realize that we must change our concepts.

We must educate our citizens if we expect to have a working democracy. We must rid ourselves of extreme ethnocentrism—that is, the feeling held by members of each social group that their culture, their way of doing things is best. (Incidentally I believe that there is far too much snobbery among nations; and also among professions, with their sterile traditions of academic specialization—too much talk about the superiority of one ac-

[1] Harold C. Urey, "Technology: Peace or War," *Social Science*, October, 1946.

[2] Dexter Masters and Katherine Way (Editors), *One World or None*, Whittlesey House, McGraw-Hill, 1946.

tivity over another.) We must learn to develop tolerance and appreciation of each other, both as individuals and as groups.

In seeking to learn the truth in social problems we must not be satisfied with misleading stereotypes. In some verses by Sloan Wilson we have examples of stereotypes which I fear are all too common; that all Russians wear beards and throw bombs; that Communists are out to kill everybody and Socialists are about the same; that Republicans will save the country and the Democrats destroy it and vice versa.[3] Of course these seem exaggerated, but after a glance at ourselves or at certain newspapers we may well wonder about our prejudices. How can we remedy these and other dangerous blind spots except by training our students so that they can make wise decisions in social affairs rather than fall prey to the shrewdest demogogue?

It took a war to make us spend two billions on atomic research. Can we not find as large an amount to promote peace? Let us try to emphasize the positive—peace and prosperity, and outlaw the negative—war and depression. Let us educate people so that they are socially wise. Let the driving motive be hope of life, not fear of death.

I hope that you do not misunderstand my attitude toward science and mathematics. As an economist I realize the great value of mathematics. Every American economist has studied long and hard the theories of Alfred Marshall, whose classical economics used Newtonian physics as a model, and the works of John M. Keynes—and both of them were trained in mathematics. Lord Keynes, perhaps the outstanding economist of our times, made notable contributions to the theory of probabilities. Much of the clarification of Keynesian economics has been made by mathematical economists. It has been said that reading without tears in economics can be more easily achieved with than without mathematics. I am not sure that I, a non-mathematical economist, fully agree with that statement, but I am certain that mathematics is a most helpful tool in social studies.

Certainly one cannot understand the atom bomb, jet propulsion, rocket planes, biological warfare and other results of the technology of mass murder without knowing something about natural science. Senator Brien McMahon, in his article, "While the Clock Ticks" (*Survey Graphic*, January, 1946), said that his now famous committee on atomic energy felt the lack of educa-

[3] Sloan Wilson, "A Political Glossary for the Uninitiated." *Saturday Review of Literature*, August 24, 1946.

tion in that field more than any other. Apparently some of the members of the Lilienthal Committee felt the same need. Fortunately, one of their members was Professor J. R. Oppenheimer who spent considerable time explaining to the non-scientific members of the committee the theory and facts of atomic energy.

We must understand our culture; and the results of science are a part of it. Every educated person must have a basic knowledge of science. Because the effects of science play so important a part in our daily lives, politics, that is, matters of public policy, hinge on highly technical knowledge. It is obvious that if we are going to solve the perplexing questions of international control of atomic energy, our politicians (I define a politician as a live statesman, that is, a person with authority and responsibility to decide public policy) and our citizens who shape public opinion must have some understanding of science. And in that understanding I believe that natural scientists can give valuable assistance by teaching the scientific method. I think they can aid in the attempt to apply rational methods to the solution of human problems. For if rational methods cannot be applied to social problems we are lost.

I believe that science and the social studies are important parts of the liberal education. I can see no reason for jurisdictional disputes among the natural sciences, the social sciences, and the humanities. We are in desperate need of all of them.

No, I do not advocate a moratorium on science. Perhaps we should do well to have a moratorium on trivia, as Norman Cousins has said, so that we may ponder the moral and political significance of Hiroshima and Nagasaki and the issues of rival sovereignties in an atomic era.

Recently there was an article in a popular magazine entitled: "Are You Smart Enough To Be a Citizen?" It went on to say that an ordinary college education is no longer sufficient in a discussion of our weighty questions, such as the Einstein theory or the matter of Manchurian minorities. Although one does not have to be an Einstein or a diplomat, it does take intelligence and education to be a citizen of a highly integrated and complex world. It is more true than ever that we are in a race between education and destruction, and we as teachers have a responsible part to play.

Let us not be discouraged by the supposed backwardness of social science. Do not forget that in the early stages of the nat-

ural sciences personal arguments and violent polemics were often substituted for reasoned opinion. Even the geniuses of science had to work with prejudices, misleading generalizations, unreal abstractions, and inaccurate observations. Let us not give up without trying to study society objectively. Remember that from Socrates to Voltaire, philosophers argued that man could study man with accurate and complete success, and that it was natural phenomena which were considered impossible to fathom. It is only recently that the study of nature has been thought more accurate than the study of man. In the Renaissance, dispassionate search for the truth was carried forward by scholars concerned with man and his relations with other men, rather than with nature.

As a matter of fact, social scientists have accomplished more than popular opinion alleges, and considerably more than has been used by society. For example, sociology has contributed more knowledge about crime and juvenile delinquincy, and economists more knowledge about international trade and governmental fiscal policy than have been adopted by society. Anthropologists have made great advances in the field of race which are most valuable in attacking racism, perhaps the most dangerous myth of the day.

In *The Economic Consequences of the Peace*, John M. Keynes forsaw the breakdown of reparation payments and the failure of the Versailles Treaty. As a matter of fact, every economist knows that high tariffs and reparation payments do not mix. Yet in spite of the advances in economic knowledge, the man in the street continues to talk of a favorable balance of trade, just as the eighteenth century mercantilist did. Social psychologists have developed, partly with the aid of mathematics, practical techniques of prediction in vocational selection, criminal recidivism, and other fields.

Professor Elton Mayo of Harvard has, through intensive research, uncovered considerable knowledge of discerning dissatisfaction and restlessness among industrial workers. Still, on the whole, the public and even management are ignorant of his research. Most of us seem to feel that ignorance is bliss in labor relations. But in times of strife when emotions are high we cry that some law ought to be passed in a hurry, and we give no thought or objective consideration to the research that has been done on the subject.

But it may encourage us to remember that such studies are

being made and that they must in time have great influence. In order that they may have weight we must educate the citizens of the world so that they may choose constructive rather than destructive courses of action. The revolution of mass education aided by the G. I. Bill of Rights is a challenge to us. A college education should not be merely the equivalent of one hundred and twenty hours. Education and more education for the citizens of the atomic world is our only hope. We must make the future work.

THE QUIZ SECTION

Julius Sumner Miller

Chapman College, Los Angeles 27, California

1. If you were at the earth's equator where would you see Polaris?
2. Assuming a steady speed of two hundred (200) miles per hour—guess quickly now!—how long would it take you to reach the moon? the sun? the nearest star?
3. Why would the danger of being struck by a falling meteorite be greater on the moon than on the earth? or would it be?
4. If we interpret "falling" as the deflection away from the straight line path it would follow if the earth's pull were absent, can *you* show that the moon "falls" toward the earth about 6300 miles in a day?
5. The boiling point and the freezing point of hydrogen are nearly identical! Is this true?
6. A red cherry stain when washed with soap changes color abruptly to blue. Can you explain this?
7. Why does tea lighten in color when lemon juice is added?
8. Quickly now! How long must you live to see 7 years of Sundays?
9. A six inch cube is painted red and then cut into inch cubes. How many have paint on three sides? on two sides? on one side? how many have no paint?

(NO ANSWERS—Teacher on vacation!!)

NOTE TO OUR READERS:

We began this QUIZ SECTION a year or more ago with several intentions in mind. We felt first that a "quiz" appealed to anyone from ages 8 to 80. We hoped to provide some interesting science for the younger readers, and to incite their interest in things scientific. We felt that teachers on all levels of instruction would find the Quiz pedagogically useful. We hoped to improve the Journal. We hoped for some response from teachers—we looked particularly for contributions from readers who had no other ambition than to see their name in print! We hoped that teachers would urge their students to contribute—with the exciting experience of having their names appear.

It is with some disappointment that we report the response to be feeble and unexciting. Could we urge you to let us know how this QUIZ strikes you. Do you read it? Do you use it? Wouldn't you like to contribute to it? Let us hear from you.

Very sincerely yours,
Julius Sumner Miller

THE SCIENCE OF CHEMISTRY AND THE CONSUMER*

JAMES R. IRVING

Maine Township High School, Des Plaines and Park Ridge, Illinois

Your most important single voluntary activity is the consuming of materials

As teachers of the science of chemistry, have you ever wondered how you could aid the student to become a more intelligent consumer? Indeed, a worthwhile question to ask for anyone planning and guiding a year of intensive scientific study.

Certainly, students will soon realize that a 10¢ bar of soap is just as good as the "special" dollar size in the fancy wrapping. They will soon learn that a solution of boric acid, worth 5¢ a gallon, may be sold under a trade-name as an eyewash for much more than its true value. They may even be shocked to learn that a popular morning-after "picker-upper," used indiscriminately, will drive them insane; that the "magic" word said to be an ingredient of a certain kind of tooth paste and tooth powder is nothing more than ordinary soap.

But that isn't all students can learn from a course in chemistry. Neither does making tooth paste and hand lotion necessarily aid them in becoming more intelligent consumers. Too many times makeshift school equipment and insufficient care in handling materials result in poor and costly products.

Prolonged study of specific "brands" may indicate their composition and prevent students from purchasing expensive products made up principally of everyday inexpensive substances; but then they possess only very specific information for a specific brand. Brand names are subject to change—new products appear on the market and without specific information interest is soon lost by the student in his role as a consumer. They, too, end up believing: "repetition makes reputation."

Basically, intelligent consumers are people possessing a thorough scientific background coupled with a mature sense of values. They are people who study a course such as this with an eye toward learning some fundamental concepts of science as an aid to living a better and happier life. They will live this better and happier life because they will learn to interpret their daily

* From the text *The Science of Chemistry* (unpublished manuscript).

environment in terms of the basic fundamental of science to follow. They will, in turn, serve society by developing better and cheaper preparations and products and by making more goods and services available to more consumers through the application of sound scientific fundamentals to technology. *This certainly is being an intelligent consumer—this is evidence enough of a mature sense of values.*

The following list of publications, periodicals, books, pamphlets, articles, and government consumer agencies should become a part of every chemistry course as students are trained (through the eyes of scientific study) to live an intelligent and worthwhile consumer life:

1. Federal Trade Commission Releases

   These are frequent reports of all the complaints filled by the Federal Trade Commission against producer violations and current advertising frauds. Read them. They're packed full of vital information released to all major newspapers of the country but seldom, if ever, printed. Something for the bulletin board. (Free to schools.)

2. Notices of Judgement Under the Federal Food, Drug and Cosmetic Act

   A report of cases instituted in the United States District Courts under the direction of the Federal Security Administration. These proceedings should be a part of every science reference reading table. Teachers may be placed on the mailing list for these publications by writing to: Federal Security Agency, Food and Drug Administration, Washington, D. C.

3. Consumers' Guide

   Issued monthly by the United States Department of Agriculture, this is probably one of the best sources (of a general type) of consumer information in the country. (Free to schools.)

4. Consumers Union, 55 Vandam Street, New York, New York

   A monthly magazine containing specific information on nationally advertised products. A weekly report, *Bread and Butter*, keeps you up to date on the latest information of interest to the consumer.

5. Consumers' Research, Washington, New Jersey

   Another monthly service reporting the activities of a private testing bureau on nationally advertised products. Publishers of Consumers Test Manual (.50).

6. Intermountain Consumers' Service, 1016 South Clarkson Street, Denver, Colorado

   A buying guide issued periodically throughout the year.

7. The American Consumer, 205 East Forty-Second Street New York, New York
8. Better Buymanship Booklets, Household Finance Corporation, 919 North Michigan Avenue, Chicago, Illinois. (Free upon request by your school librarian.)
9. The Consumer, Consumers National Federation, 205 East Forty-Second Street, New York, New York
10. Bulletins of the National Better Business Bureau, Chrysler Building, New York, New York
11. Consumers Digest, Consumers' Institute of America, Inc., Washington, New Jersey

The following books contain significant consumer information for the student of science. They are recommended for reference reading.

Ahrens, Maurice R., Norris F. Bush and Ray K. Easley. *Living Chemistry.* New York, Ginn and Company, 1942.
Chase, Stuart and F. J. Schlink. *Your Money's Worth.* New York, The Macmillan Company, 1927. (Of historical interest for all consumers.)
Clark, Thomas Blake. *The Advertising Smokescreen.* New York, Harper, 1944.
Gaer, Joseph. *Consumers All.* New York, Harcourt, Brace and Company, 1940.
Shields, H. G. and W. Harmon Wilson. *Consumers Economic Problems.* New York, South-Western Publishing Company, 1940.
Trilling, Mabel B., E. Kingman Eberhart and Florence Williams Nicholas. *When You Buy.* New York, J. B. Lippincott Company, 1938.
Trilling, Mabel B. and Florence Williams Nicholas. *You and Your Money.* New York, J. B. Lippincott Company, 1944.

Some interesting booklets, pamphlets, articles, etc. for (and against) the consumer. Find a place for them on your magazine rack.

Get Set to Sell. (pamphlet) National Association of Manufacturers, New York. 1944. (Top producers speak their minds—"Make People Want Things They Don't Need"—poor little consumer!)
Index to American Society for Testing Materials. (Issued Yearly.) Philadelphia, Pa. (A good illustration of the producer's methods of buying according to standards.)
The Place of Science in the Education of the Consumer. National Association of Secondary School Principals, Washington, D. C., 1945. (Something of interest for the science teacher and student.)
Chemicals in the Home. J. O. Frank, Oshkosh, Wisconsin, 1937. (Safety in the home through a knowledge of common chemicals used in the home.)
A Study of Informative Labeling. United States Department of Agriculture, Washington, D. C., 1939. (A study of what the consumer would like to see on the label.)
The Truth About Subsidies. National Farmer's Union, Denver, Colorado, 1944. (Pamphlet)

Definitions and Standards For Food and Definitions and Standards of Foods and Drugs. (May be secured from: Sup't of Documents, Washington 25, D. C. 15 cents.)

Federal Food, Drug and Cosmetic Act and General Regulations for its Enforcement, Revised July, 1946. (May be secured from Sup't of Documents, Washington, D. C. 15 cents.)

Specifications for Commercial Supplementary Teaching for Science. (Standards set up by a committee of the National Association of Science Teachers to aid science teachers to better evaluate various materials issued from various commercial sources. May be secured from: Better Business Bureau, New York. $1.00.)

A tremendous amount of valuable consumer information is furnished by the following government agencies. Much of this material is free. Materials charged for are inexpensive. Have each member of the class select one agency and write for information furnished by each office. Plan a period of discussion on the various consumer services offered by the government.

U. S. Department of Agriculture: Farm Security Administration Bureau of Human Nutrition and Home Economics; Production and Marketing Administration; Bureau of Agricultural Economics; Farm Credit Administration; Extension Service; Rural Electrification Administration; Forest Service.

Federal Security Administration: Public Health Service; Food and Drug Administration; U. S. Office of Education.

Deparment of Labor: Bureau of Labor Statistics; Children's Bureau.

Department of Commerce: Bureau of Foreign and Domestic Commerce; National Bureau of Standards.

Department of the Interior: Solid Fuels Administration.

United States Civil Service Commission

United States Employment Service

United States Post Office Department

Veterans Administration

Federal Deposit Insurance Corporation

Federal Trade Commission

NEW SCIENCE ADVENTURES FILMS ON BASIC BIRD STUDY

A new series of six discussional slidefilms, "Basic Bird Studies," has been produced and made available by The Jam Handy Organization. This series, a unit of the Science Adventures group, provides the teacher or lecturer with a comprehensive, carefully planned foundation for the study of bird life and may be used as a part of the general science course. This series is more than a mere group of bird photographs—it is a time-saving teaching and study "tool" complete in itself and yet designed to tie in with reading materials, experiments and field trips where programs permit. Subjects are: 1—Structure of Birds. 2—Adaptation of Birds. 3—Birds' Nests. 4—Migration of Birds. 5—How Birds Serve Man. 6—Helping the Birds. For details, write to The Jam Handy Organization, 2821 E. Grand Blvd., Detroit 11, Michigan.

TRISECTION OF THE ANGLE

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A popular misconception of amateur geometricians of this sophisticated age is that the trisection of the angle is "impossible." What is referred to, of course, is the proof made in recent years that the trisection is impossible by *Euclidean means* (straight-edge and compass only). Many people fail to note the distinction.

Ignoring Euclidean limitations the trisection still remains a possibility and still proves to be an intriguing problem. Many solutions have been offered but those involving elaborate or approximate methods, or special equipment, etc., are hardly the desired answer. Herewith is presented a simple method, using only straight-edge, transparent paper, and pencil, and susceptible of geometric proof.

Given the angle *DOE* to trisect (Fig. 1).

Use two sheets or portions of paper. On the first lay off the given angle (Fig. 1). The second sheet should preferably be partially transparent, having one straight edge, *AC* (Fig. 2). Fold paper along line *BH* and crease sharply, edge *AB* lying evenly on edge *BC*. The crease, *BH*, will then be at right angles to edge *AC*.

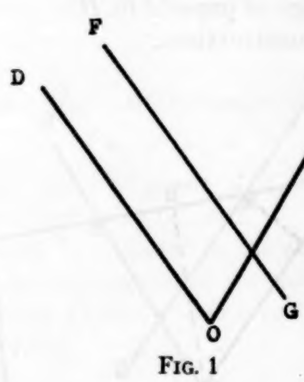


FIG. 1

While paper is folded over mark two points, *M* and *N*, on edge *AB*, equidistant from point *B*. (This may be conveniently done by making a slight nick in edge of doubled sheet of paper with thumb nail.) The distance *MB* may be any distance convenient to the scale used. Open paper *ABCH* and lay out flat.

On the given angle, DOE, draw construction line FG (Fig. 1), parallel to DO and at a distance $NB = MB$, from DO. Paper $ABCH$, or any geometrical method, may be used for doing this. Then with paper $ABCH$ lying flat over the angle DOE shift $ABCH$ around until point M lies on line FG, and N on line EO and the line (crease) BH passes through vertex O of angle DOE (Fig. 3). Mark location of point M on FG, N in EO, and B wherever it comes. M, B and N, of course, will lie in a straight line. Discard paper $ABCH$.

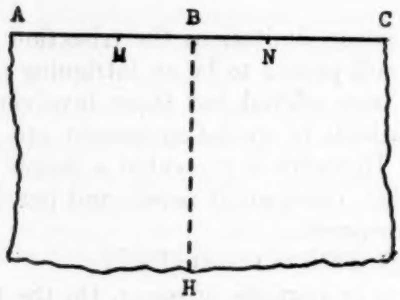


FIG. 2

Lines OM and OB trisect angle DOE (Fig. 4).

Proof:

Draw line MBN. This will be a straight line because originally laid out on straight edge of paper $ABCH$.

Also $MB = BN$, by construction.

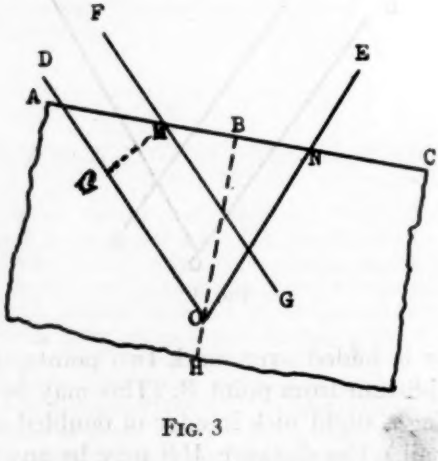


FIG. 3

And MN is at right angles to OB, by construction. Angles

MBO and *NBO* are both right angles and *OB* is common to triangles *MOB* and *NOB*.

Therefore triangles *MOB* and *NOB* are congruent (two sides and included angles equal, each to each), and angle MOB = angle *NOB*.

From point *M* drop a perpendicular, *MC*, to line *DO* (Fig. 4).

$MC = MB$, by construction (line *FG* was drawn in at distance *MB* from *DO*).

Triangle *OCM* is a right triangle (by construction), having base *MC* equal to base *MB* of triangle *MOB* and hypotenuse *MO* is common to triangles *COM* and *BOM*.

Therefore triangles *COM* and *BOM* are congruent, (right triangles having hypotenuse and one side equal, each to each, are congruent).

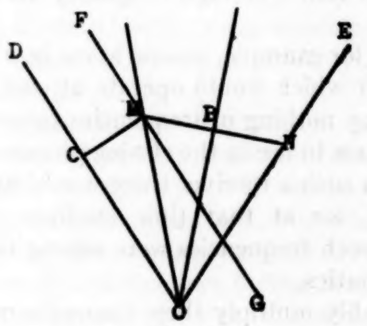


FIG. 4

And angle COM = angle MOB = angle $BON = \frac{1}{3}$ angle *DOE*.

* * * *

Instead of using a piece of paper, *ABCH*, a transparent ruler having suitable markings may be used.

Angles to 180° may be trisected in the above manner.

This method is an adaptation of the more elaborate method based on the Ternoid Curve, $y^2 = (x-2a)^2 (x+a)/(3a-x)$, the invention of the writer.

PLASTIC WRAPPING FOR BRAIN SPECIMEN

Human brains and other specimens for use in physiology classes may be kept for two years in a transparent plastic wrapping, through which they are easily studied. The specimen, removed from a formaldehyde solution, is sealed within the covering: a plastic ruler beneath protects the tissue from the sealing iron.

A PROPOSED DEFINITION OF ELECTRONICS

ROBERT STOLLBERG
Wabash College, Crawfordsville, Indiana

Electronics has become a household word. As a result of the urgent demands created by the recent war, physicists have greatly increased their ability to control the behavior of electrons. The needs of the fighting forces have been met with such military applications as radar, loran, and guided missiles. These accomplishments have been well publicized and have succeeded in awakening popular consciousness. However, we would commit a grave error to suppose that they were latent developments, the emergence of which merely awaited a national crisis. Prerequisite to their appearance was the acquisition of the necessary "know-how" of high-frequency techniques in electronics.

A decade ago, for example, no one knew how to make a really sensitive receiver which would operate at, say, a billion cycles per second, to say nothing of frequencies more than fifty times as great which were in use in the closing phases of the war. Even if there had been such a receiver there would have been nothing worth receiving, for at that time medium- and high-power transmitters at such frequencies were among the wilder dreams of electronics fanatics.

One could readily multiply these examples merely by tracing through a radar circuit. Here would be found components unheard of a dozen years ago, including multiple-cavity magnetrons, improved pulsing and triggering circuits, tricky delay lines and filters, precision electronic controls, new high-amplification vacuum tubes, more efficient wave-guides, and increasingly effective antenna arrays. These are but samples of the advancing front of electronics knowledge accelerated by the national emergency, and essential to the astonishing electronics developments characteristic of the war.

Close on the heels of research workers come the production engineers, improving already existing devices such as radios, industrial electronic controls, and fluorescent lights, and bringing to the public relatively new ones, including magnetic tape reproducers, pocket-sized radios, and improved electronic aids not only for the deaf but also for the blind. As new developments appear on the research frontier, these engineers are alert to their possibilities in terms of producing new consumer devices,

improving old ones, and manufacturing them more economically.

Almost touching the elbows of these wizards of production are the men of the sales department, who with the aid of double-spread magazine advertisements, radio commercials, and all their other techniques, have so effectively informed the public of new consumer goods, seeking to create in the reader or hearer of that information a desire for these devices. It is largely these sales experts, aided of course by newsmen, fiction writers, motion picture scenarists, and funny-book producers, who have made the people of these United States thoroughly aware that electronics is definitely here to stay.

But in spite of all these assorted activities in the field of electronics, few if any of those engaged in it have taken time out to state what that field really is, what it includes, what it excludes, how its content is related to the more familiar field of electricity. In short, there seems to be no satisfactory and authoritative *definition of electronics*.

In the course of his own teaching, both in civilian and military capacities, the writer has been repeatedly confronted with this lack of a suitable definition of electronics. With the help of many students and colleagues, a statement has been drafted which meets the needs of most persons. It is intended to include all those features which workers in the field envision as electronics, and yet to exclude those aspects which they feel belong more rightly to the field of general electricity.

"Electronics is that branch of electricity which is concerned with the flow of electrons through an enclosed and partially evacuated space."

Electronics is here identified as a *branch of electricity*, an area of science which, in its turn, is also extremely elusive of definition. However, it is a workable assumption that readers understand it to be concerned with electric currents, and hence inseparably associated with the flow or storage of electrons. Until the advent of electronics, however, a flow of electrons was considered to take place only in wires or other conductors, or in an electrolyte. By the foregoing definition, electronics is associated with a *flow of electrons through an enclosed and partially evacuated space*. This phrase implies a definite volume of a gas or mixture of gases, the pressure of which is rarely more than one millionth of an atmosphere, and frequently much less.

This definition is designed to include not only the study of

"vacuum" tubes—those from which as much gas as possible has been removed—but also gas-filled ones, such as mercury-vapor types. In the latter case, although the flow of *ions* through the space plays a significant part in the conduction of the current, this ionic flow is accompanied by and is impossible without a flow of *electrons*. Of course, the exact nature of the definition would not be seriously altered if the words "charged particles" were substituted for "electrons." However, since electronics is far more frequently concerned with a flow of electrons than it is with a flow of ions, the former terminology is preferred.

It is to be noted that no mention is made of the *source* of the electrons. They may be thermionically emitted from a cathode. However, in many gaseous tubes, including neon-type lamps, gas-discharge tubes such as voltage regulators, photoelectric cells, and cold-cathode rectifiers, electron emission is virtually independent of cathode temperatures.

This definition does not include natural phenomena associated with a flow of electrons through space, on the ground that they do not occur in an *enclosed* space. This modifier is introduced into the wording in order to exclude lightning, the aurora, and other such out-of-doors displays. Should one for any reason wish to include these features in the realm of electronics—and such a decision is a matter of opinion, not one of right or wrong—it can be accomplished merely by eliminating the word "enclosed" from the statement.

Evidently this definition implies close connection with the use of typical radio tubes or vacuum tubes. But what of the remaining components of devices in which they are used—transformers, capacitors, resistors, indeed the wiring itself—all of which behave in exactly the same manner as though they were in an electric but not an electronic device? According to the definition, an electronic device is one which is characterized by a flow of electrons through space. In a radio receiver, for example, the reactors, capacitors, resistors, and conductors are all most intimately associated with vacuum tubes, which are clearly electronic in nature. Hence, as used in a receiver, these related components are considered to be electronic units. On the other hand, the same varieties of parts used in an electric power distribution system would be considered as electrical components, but not electronic ones.

There are many border-line cases. Consider, for example, electronic controls for electric motors, those remarkable circuits

which permit such delicate and efficient control of direct-current motors from alternating-current power sources. Although the entire system, from power line to motor, is essentially one of *electric* power, the control circuit itself is characterized by, not merely associated with, the flow of electrons through space. Hence, according to the proposed definition, it is an *electrical* power system with an *electronic* control device.

The definition of electronics proposed here quite evidently and quite properly includes audio amplifiers, such as are used in juke boxes, hearing-aids, and intercommunication sets, radio transmitters and receivers, radar, television, electronic motor controls, photo-electric devices, cathode-ray oscilloscopes, and electron microscopes. Although usually not studied with electronics, items such as mercury- or sodium-vapor lamps, fluorescent lamps, and x-ray devices are clearly included in this definition.

On the other hand, certain features commonly associated with radio are as clearly excluded. For example, an old-time spark-gap transmitter, the radiation itself, and its reception and reproduction by means of a simple crystal detector are all quite outside the realm of electronics, since there is no flow of electrons through an enclosed space involved. As mentioned before, lightning and the aurora are excluded; of course simple telephone and telegraph circuits, as well as incandescent lamps and electric motors and generators, are completely outside the area of electronics.

These inclusions and exclusions are not intended to imply that textbooks or courses of study concerning electronics should include all that is in this definition and nothing more. Many engineering books in the field of electronics, for example, are textbooks on radio communication, and such subjects as electromagnetic radiation, non-electric rectification, and frequently electric power distribution systems are essential, to say nothing of a treatment of elementary electricity. Textbooks or courses featuring electronic audio systems should certainly consider the nature of sound, and those including television or subjects associated with photo-electricity must almost inevitably include material concerning the nature of light.

This definition is proposed, then, not to make things harder by including with electronics those materials which do not naturally belong there, or by excluding from it those which should rightly be included. It is not presented as a step in an "ax-grinding" campaign to set electronics on a pedestal above the

plane of "old-fashioned electricity." This definition and discussion may benefit scientific philosophers and purists who desire that every branch of scientific knowledge be clearly identified in its relation to the entire body of science. However, the principal hope is that it will help others to think more clearly about the field of electronics, an extremely significant feature of our increasingly technological age.

SOME NOTES ON PROBLEM SOLVING

K. L. YUDOWITCH
University of Missouri, Columbia, Missouri

How often is it that a student will profess to be completely unable to solve a problem; and then by appropriate prodding be made to work the problem by himself—completely and correctly? Having found this to be the case quite frequently with my physics students, and having found that the prodding needed generally follows a common pattern, I devised the following portable prod—in the form of a set of rules for systematically attacking a problem.

Having mimeographed and distributed these rules, I find fewer students come for help only because they *think* they can't solve a problem.

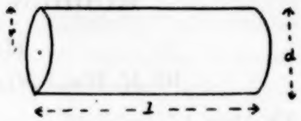
1. Decide what bodies or particles to consider.
2. Draw a figure showing all essential components of the problem.
3. Label all quantities with consistent letters.
4. Tabulate the data, including constants and special conditions—all with units.
5. Determine and write down the general equations, including geometrical as well as physical relationships.
6. Write down the specific equations, using the labels designated in rule 2—appreciating what each quantity is.
7. Check the equations for solvability. X unknowns require X equations.
8. Solve the equations for the desired quantity.
9. Substitute the numerical values tabulated under rule 3.
10. Check your result, both for reasonability and units.

Let us now clarify by means of a simple example:

Problem; Find the volume of a cylinder of length 2.0 meters and diameter 1.0 meter

Solution:

1, 2, and 3.



4. $l=2.0$
   $d=1.0$
   $\pi=3.1$
5. $V=l\times A$
   $d=2r$
6. $V=\pi r^2 l$
   $d=2r$
7. 2 equations; 2 unknowns (V and r)
8. $r=\dfrac{d}{2}$

$$V=\pi\left(\frac{d}{2}\right)^2 l$$

9. $V=3.1\left(\dfrac{1.0}{2}\text{ meters}\right)^2\times 2.0\text{ meters}$

   $V=1.6\text{ meters}^3$
10. Units for volume correct; value reasonable.

These rules are somewhat similar to those observed by the writer in Dadourian's "Analytical Mechanics," and possibly appearing in other places.

ALUMINUM ALLOYS CONTAINING BERYLLIUM HAVE INCREASED TENSILE STRENGTH

New aluminum alloys, containing small amounts of beryllium which increases their tensile strength, were revealed by General Electric research laboratory. They open new fields for aluminum uses.

Their resistance to being pulled apart is from 30% to 80% greater than present commercially-available aluminum casting alloys, it is claimed. They resist corrosion, have high thermal stability, and can be both cast and wrought.

Zinc alloys containing beryllium, developed during the past year, possess spring qualities comparable to brass and have other qualities that make them more usable for many applications than the present commercially-available wrought-zinc alloys.

A process for brazing ceramics to metal is important, particularly in the vacuum tube field. In this method, the creamic is coated with titanium by heating in pure dry hydrogen or in a vacuum, then applied to the metal and brazed with copper by heating again in hydrogen or a vacuum.

RUBBER AND PLASTICS*

H. E. Brown
W. M. Welch Mfg. Company, Chicago, Illinois

The kinship of rubber and plastics was emphasized throughout by

First—by the method of fabrication through the application of heat and pressure to produce a desired form and shape;
Second—by the similarity of the kinds of components used in the mix;
Third—by the comparable chemical structure of chains of unsaturated hydrocarbon molecules;
Fourth—by the similar range of physical tests made on both products.

Brief historical milestones in rubber include

1. Mayan rubber articles brought to Europe in 1770,
2. Making of "mackintosh" raincoats in 1825,
3. Accidental discovery of vulcanization in 1839.
4. First seedling rubber tree plants grown in 1879, to the
5. Present program of 800,000 tons of artificial rubber yearly.

Slides, and explanation, showed Mayan rubber articles, rubber plantations, collection of sap, mixing mills, and vulcanizing chambers.

Isoprene, C_5H_8, or natural rubber has never been synthesized but many other unsaturated hydrocarbons with similar properties have been made, such as butadiene, chloroprene, butaprene S, etc. Empirical and structural formulae were shown as slides and the changes upon polymerizing, i.e. long chains of unsaturated molecules attaching to each other producing very large molecules some having a molecular weight of about 500,000.

Vulcanization is tying these chains of unsaturated molecules together by means of sulphur atoms.

The wide variety of raw materials used (such as petroleum, gas, potatoes, grain, sugar, etc.) and the many materials included in the rubber "mix" result in artificial rubbers of various properties. This makes it necessary to do much testing of the properties of the rubber produced.

The function of the physics teacher in preparing his students for work in this industry can best be performed by teaching a good course in physics which stresses the meaning, significance

* Digest of a paper presented at the Physics Section of Central Association of Science and Mathematics Teachers at Detroit, Michigan, Nov. 29, 1946.

and method of measuring such physical properties as specific gravity, viscosity, tensile strength, modulus, tear resistance, hardness, abrasion, resilience, dielectric strength, specific resistance, specific inductive capacity, power factor, etc.

Typical testing machines as used in the industry were shown as slides, as well as others such as plastometers; resiliometers; flexcracking machines; machines to test rubber mountings; artificial aging devices; resistance to oils, grease, acids, water, etc.; and also testing of fibers and threads which are used to reinforce rubber.

An oxygen bomb (a chamber containing oxygen at 300 lbs. per sq. in. and 70°C.) produces the same aging effect on rubber in 12 to 24 hours as one year of shelf aging. The air bomb (a chamber containing air at 80 lbs. per sq. in. and 127°C.) is an approximately 25 times more rapid aging test and few rubbers survive more than 10 hours in this bomb.

The methods of manufacture of plastics was explained, as well as the chemical structure of a few (showing polymerization). The raw materials used and the variety of components of the "mix" emphasize again the kinship of rubber.

The need for training in physics is even more important in the plastics industry because of the wide variety of tests made on plastics, such as: toughness, tensile strength, specific gravity, modulus of elasticity, viscosity, compression strength, impact strength, heat conductivity, combustibility, softening temperature, specific heat, coefficient of expansion, distortion under heat, electrical conductivity, color, translucency, odor, taste, effects of moisture, light, heat, age, and resistance to oils, acids, and other chemicals.

The size of the plastics industry was discussed and figures given showing the plastics industry to be comparable in size to that of its cousin rubber.

The popularity of plastics with manufacturers is to a considerable extent due to the fact that so many shop processes may be readily employed with plastics. They may be sawed, punched, drawn, polished, embossed, formed, bent, drilled, milled, tapped, planed, engraved, carved, turned, sheared, ground, threaded, etched, plated, woven, etc.

The popularity of plastics with the consumer is in large part due to the possibility of producing colorful products.

A very large variety of samples of plastic products were exhibited. This covered such groups as—

1. Molded pieces—meter cases, tumblers, plates, pulleys, etc.;
2. Extruded products (squirted through discs)—rods, tubes, belts, threads, fountain pen barrels, tool handles, moldings, etc.;
3. Laminated or coated products—water repellent cloth, artificial leather coatings for cloth, impregnation for prevention of shrinkage of woolens upon washing, transparent washable chart coatings, sheeting for aprons, wrappings, etc.
4. Miscellaneous—
   a. Plastic screen wire,
   b. Liquid plastic—adhesives,
   c. Containers—boxes, vials, bags, etc.,
   d. Printed, engraved and plated plastics,
   e. Plastics reinforced with metal or wire mesh,
   f. Fabrics such as used for upholstery and also dress fabrics containing part plastic fibers,
   g. Bonded wood, metal, cloth and paper to make sheets such as "Formica," for table tops, etc.
   h. Combination of phosphorescent and fluorescent materials with plastics.

One of the newest developments in plastics is the use of electronic heating by high frequency currents of the order of three million cycles per second—the same type of heating that we read that frozen food can be thawed in a few minutes.

There followed a demonstration of molding using a small 4-cavity mold, electrically heated, and placed in a press under 15,000 lbs. per sq. inch pressure to make from Bakelite powder a small gasket or washer for insulation in a switchboard meter.

A chart was shown with the suggestion that each school might construct one. It consisted of a board about 30×40 inches displaying samples of each of the varieties of plastics mentioned above. Such a chart would not only be interesting and instructive for the students to build but would make a desirable permanent wall exhibit for class-room or hallway walls.

NEWLY PATENTED APPLE TREE BLOSSOMS LATE, DODGING FROST

A reluctant apple tree, that blossoms a month later than its orchard-mates and thereby escapes late spring frosts, is announced through the medium of the U. S. plant patent 722, just issued here to its originator, Max Bazzanella of Mineral, Va. The tree originated as a seedling on his farm in Louisa County, Va., about 15 years ago, and has been in bearing for a decade. Mr. Bazzanella states that he has propagated it by bud-grafting, and finds its cions true to the parent type.

The medium-sized fruits are described as spicy and sub-acid, with a quince-like flavor. The originator regards the new variety as especially suitable for drying and for general home use.

VITALIZING THE ELEMENTARY SCIENCE PROGRAM

EDWARD POWERS
Larkfield School, Northport, L. I.

It is a notable fact that our schools lag behind scientific progress. Nowhere is this more evident than in the elementary schools, where the study of science has its foundational beginnings. Too often science is either ignored completely, or given lip service through the mere reading of texts. A program carried out in the latter manner is foredoomed to failure. The reason for this is obvious. Science is a study of the natural and physical environment. This environment cannot be understood by mere reference to a book. It must, rather, be seen, felt, heard, and in general, be brought closer to the natural and instinctive curiosity that is prevalent in all children. Capitalizing on this curiosity the environment should be brought to the classroom. Children should be given the opportunity for close contact with the forces and materials that surround them. The results achieved when this is done are amazing. Science becomes an interesting, vital, challenge to the children.

Many elementary teachers have meager science training and thus shy away from the teaching of it. Science to them is a mysterious world closeted behind barriers of research and immersed in technical verbiage. It is remote and somewhat frightening.

This point of view is totally wrong. Any elementary teacher who is capable can do a fine job with science. The simple requirements are a sincere desire to help children with science and the ability to stimulate the students in her charge.

How can we make elementary science more meaningful and vital? The answer to this problem can be found in the child. He will not understand the abstrast. He is not interested in the remote. His desire to learn is only stimulated by the things that are within his range of understanding.

Let us take, then, the various aspects of science such as heat, electricity, nature, rocks, air, magnetism, fire, water, machines, astronomy, light, weather, food, aviation. These are but a few of the general areas.

How should these units be taught? By teaching them through the mediums that a child can understand. The most successful

elementary science teacher is one who selects an area of study and then considers all the elements of it that are familiar in the life of a child.

For example—suppose a unit on machines is being taught. The most comprehensive understanding of this area can be developed through the use of such familiar devices as hammers, bicycles, toy cars, erector sets, clothesline pulleys, can openers, nutcrackers, scissors, scout knives, doorknobs, keys, screwtop jars, and ball bats. Every child uses these and what child is not willing to bring such items into the classroom? To them it represents play, but to the teacher it becomes an invaluable aid to the understanding of the six simple machines. Through play, discussion, and demonstration the child will learn more about these devices as machines than weeks of reading could teach. Then what intelligent teacher would not send the children hunting in their homes for more machines to be catalogued as a lever, wheel and axle, pulley, wedge, screw, or inclined plane. Even the complicated machinery of home, school, and industry can be investigated in terms of these.

Any unit taught in this fashion can make teaching a stimulating experience and learning more interesting and meaningful. Does this require years of scientific training? No, all it demands is the desire to think and see as a child would see it.

Electricity is familiar to every child and the mere mention of the subject will arouse his curiosity. It seems logical, therefore, for them to bring in fuses, wires, switches, light bulbs, toasters, hot plates, Christmas tree lights, plugs and other items of this nature. They can play with them and learn many valuable things. If we are to learn about sockets the best way is to take them apart. Old light bulbs can be broken and examined. Toasters can be connected and studied. Through Christmas tree lights they learn series and parallel circuits. Simple electric motors can be made, dry cells taken apart. With a few dry cells they can learn to make circuits and short circuits. Fuses can be "blown" easily by a simple demonstration. With their dry cells they can discover what substances conduct electricity. All types of insulators are available in their homes for use in the classroom. Why not bring in an electric train or two? Surely this can be a learning situation. The transformer could be taken apart. These represent but a few thoughts on what can be done in this field with no mention of the great implications for safety teaching in this area.

Or—the study of air. What child would not love to bring in to class such items as kites, balloons, model planes, fountain pens, soda straws, sailboats, toy parachutes, sink pumps, siphons and basketballs. Yet, with these any elementary teacher with a minimum of research can utilize these famil ar materials and weave a splendid pattern of study on air. Out of this can develop a study of aviation. Students can make model planes in class and with little difficulty can learn more about planes than hundreds of pictures could teach him.

In studying weather a class could have a lot of fun building a weather bureau on the school playground. Some simple carpentry, a few instruments borrowed from the high school, a thermometer, a home-made wind vane, an anemometer, a tin pail, and a metric ruler to serve as a rain gauge, plus a chart for recording the weather conditions observed with these devices can make any child a pretty good weather forecaster, not to mention the learnings derived from the instruments. In addit on he will form the habit of observing his surroundings and his curiosity will grow and expand into other areas.

Thus, we have seen that with a minimum of study, a willingness to see things through the eyes of a child, and good organization any teacher can be a successful, stimulating teacher of elementary science. Children love to hunt, find, and bring things to school. Capitalizing on this instinctive urge the teacher can direct it to her ends and weld elementary science into a useful and challenging experience for teacher and child.

A METHOD FOR TEACHING FORMULA WRITING AND STRUCTURAL DIAGRAMING IN HIGH SCHOOL CHEMISTRY*

Kenneth E. Anderson
University High School, University of Minnesota, Minneapolis, Minnesota

The first and second articles outlined the method for binary acids and for trinary acids. This article outlines the method to be followed in writing formulae and structural diagrams for salts. By definition a salt is a metal plus an acid radical. This means that the hydrogen of the acid has been replaced by a metal.

* This is the last of a series of three articles.

All binary salts are derived from the hydro (acidic element) ic acids, and all binary salts end in (acidic element) *ide*.

e.g. Hydro*sulfuric* acid—sodium *sulfide*
(acid) (salt)

Most of the rules used in naming trinary salts are embodied in the chart shown below. Students will find this very helpful in writing formulas for trinary salts.

Name of the Trinary *acid*	Name of the Trinary *salt*	Valence Choice		
		4 chances Cl, Br, I	3 chances S	2 chances N, P, As, Sb
Hypo(central element)ous Hypochlorous acid	Hypo(central element)ite Sodium hypochlorite	1	2	—
(central element) ous Chlorous acid	(central element) ite Sodium chlorite	3	4	3
(central element) ic Chloric acid	(central element) ate Sodium chlorate	5	6	5
Per (central element) ic Perchloric acid	Per (central element) ate Sodium perchlorate	7	—	—

Some salts have special names based on the following:

1. Primary—one hydrogen atom of the acid has been replaced by an atom of a metal.
2. Secondary—two hydrogen atoms of the acid have been replaced by two atoms of the metal.
3. Tertiary—three hydrogen atoms of the acid have been replaced by three atoms of the metal.

Occasionally one encounters the use of the prefix *bi*. In this event, the prefix *bi* is to indicate that one-half of the hydrogen of the acid has been replaced by a metal.

I. Sample for writing formulas for binary salts. Determine the correct formula for the acid, and then the correct valence for the acid radical. This valence is equal to the number of hydrogen atoms. Replace the hydrogen by the metal indicated in the name. The example below is that for barium sulfide:

1. H^1S^2
2. H_2S_1
3. H_2S
4. S^2 (Acid radical with valence)
5. Ba^2S^2 (Replace Barium for hydrogen)
6. Ba_2S_2
7. Ba_1S_1 (Reduced)
8. BaS (Drop 1's)

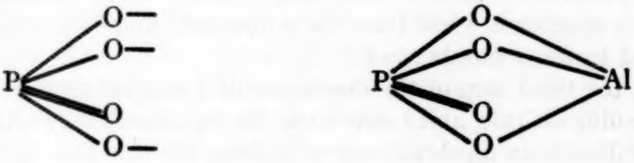
Structure

1. S
2. S=
3. S=Ba

II. Sample for writing formulas for trinary salts. Determine the formula for the acid. Determine the valence of the acid radical. Replace the proper amount of hydrogen by the metal indicated. The example below is that for aluminum phosphate:

1. Oxide P^5O^2
2. P_2O_5
3. $P_2O_5+H_2O+H_2O+H_2O=H_6P_2O_8$
4. H_3PO_4
5. $(PO_4)^3$ (Acid radical with valence)
6. $Al^3(PO_4)^3$ (Replace hydrogen with metal)
7. $Al_3(PO_4)_3$
8. $Al_1(PO_4)_1$ (Reduced)
9. $Al(PO_4)$ (Drop 1's)

Structure:



NOTES FROM A MATHEMATICS CLASSROOM

JOSEPH A. NYBERG
Hyde Park High School, Chicago

129. Graphs of Equations. In the seventh and eighth grades a pupil learns to interpret and to draw statistical graphs. In high school his text books in science, civics, geography and even his comic books contain so many such graphs that it is hardly necessary for the algebra teacher to discuss them. Hence in the algebra class the work on graphs may well be limited to the graphs of equations. After the pupil has learned about rectangular coordinates and the plotting of points, the problem for the teacher is: How shall the graphs of equations be introduced?

I begin by plotting (on the blackboard) some points $(-2, -6)$, $(-1, -3)$, $(2, 6)$, $(4, 12)$, and asking: What is true about the numbers that locate these points? Evidently $y=3x$. In addition to writing this equation on the board (but *not* drawing

the line through the points) I use and emphasize the phrase "the y number is 3 times the x number." I like this phrase better than "the ordinate is 3 times the abscissa" or merely "y is 3 times x" because I like to emphasize that y and x are *numbers*. I then use a few similar problems leading to "the y number is 4 times the x number," " the y number is 2 more than the x number," and "the y number added to the x number is 10." I am careful to avoid a set of points like (2, 3), (3, 3), (4, 3), (5, 3), a set like (3, 4), (3, 5), (3, 6), and a set like $(-2, -1)$, (0, 3), (2, 7), (3, 9); these sets would very likely start an argument and divert attention.

Next I suggest to the class that we reverse the problem: I will state what is true about the y number and the x number, and the class will find the points. Note that I did not say that I will state the equation and the class will plot the points. I begin with "the y number is 3 more than the x number," and continue with "the y number is 4 less than the x number" and "the y number added to the x number is 8."

At the third step of the development I suggest that we try a more difficult rule, and I now write the equation $x+2y=10$, and add "This is an algebraic way of writing the rule that the numbers are to obey; that is, the x number plus twice the y number equals 10." I hope that there will be some hesitation in the class so that I can ask the dullest pupil to come to the board and mark any point at all so that we can "test the numbers to see if they obey the rule." If the pupil plots, for example, the point (2, 3), we test these numbers and conclude that if we kept the x number the same and could make the y number larger, the numbers would satisfy the rule. A second pupil guesses a possible point, tests the numbers, and moves the point up or down until the numbers are satisfactory.

Finally, if no bright pupil comes to our rescue, I suggest: after marking a possible point, we pushed it up or down until the numbers were satisfactory; isn't there some better way to find how much the point should be pushed up or down? If the rule is $x+2y=10$, and we have a point for which $x=3$, how can we find what number y should be? Evidently we want $3+2y=10$.

The object of this treatment is (1) to avoid telling the class that we should choose some values for x and make a table of corresponding values of x and y, and (2) to develop the notion that the graph is a locus of points that satisfy a certain rule. I hope that choosing a point at random, testing its numbers, push-

ing the point up or down (or to the right or left), and learning that the equation decides the right amount of "push" will clarify the concept of locus.

The preceding work will require a period of forty minutes. The next day we can learn that for a linear equation the locus will be a line, and so forth.

130. How To Use a Book. When introducing a topic I prefer in most cases to follow the textbook, developing the concepts exactly as the text does. At times I have used a text that I believed to be a poor one, but I have followed it almost religiously. I may have disagreed with its explanation of subtraction, for example, but I have developed subtraction by the method in the text. I may have disapproved of the order in which factoring was taught, but I have followed that order. I do this for several reasons. I want the pupil to have confidence in his text so that he will study it. I want the pupil to learn that it is possible to learn by reading, so that he will consult his text if he is absent some day or needs to refresh his memory at some time. I do not want to use a text merely as the collection of exercises from which I select those that are to be solved.

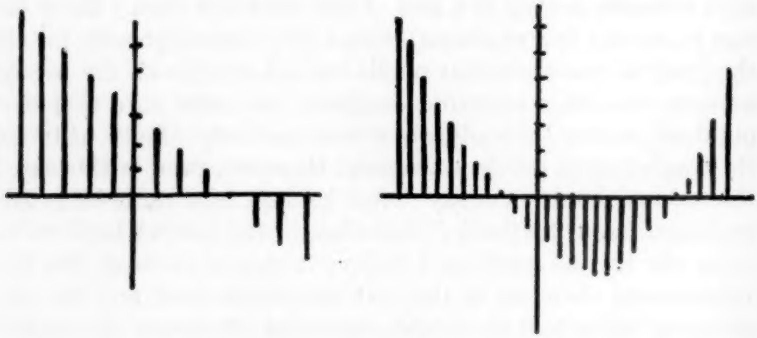
But no text can contain all the questions that a teacher could, would and should ask. Realizing this fact, some texts contain *developmental* exercises which aim to do exactly what I have illustrated in the treatment of graphs of equations. Such exercises certainly belong in a text. Their weakness (and I know no way to correct this weakness) is that they cannot provide for all the possible questions that pupils can ask nor for all the wrong answers that they sometimes suggest, nor make sure that the pupil will answer the leading questions correctly. Hence, at times the teacher must do the *developing*. However, even in this case, the teacher should next say "Now let's see how these ideas are explained in our textbook." And then (if the teacher believes in using the text as much as I believe it should be used) the developmental exercises in the text should be used, and the explanation in the text thoroughly discussed. Obviously the pupil's confidence in his text is not increased if the teacher's development differs from that in the text, and the pupil becomes increasingly reluctant to study his text. He thinks "I can't understand the book; I'll wait and let the teacher explain it."

Some teachers may think that my attitude belittles the teacher and deprives him of an opportunity to be an inspirational force. My attitude is exactly the opposite. Because a

teacher's words have more effect on the pupil than the textbook, the teacher must be careful of every word he uses. In the work on graphs of equations, for example, I select in advance the points I intend to use. The pupil is unaware that my choice is written on a sheet of paper on my desk; he thinks I am using *any* points.

To impress a new apprentice with the importance in class of everything that he did I once asked him, "why, in answer to that question about dividing, did you use $4x=16$ as an example? Might you have used $5y=20$? and when you had answered the pupil's question you walked to the right of the desk. Would it have made any difference if you had walked to the left? It might have looked as if you were walking away from that pupil. Perhaps he will think you don't like his questions. And once you picked up a piece of chalk, put it down, and picked up a different piece? What was wrong with the first piece?" To all of this the apprentice answered "Do those little things make any difference? I'll be scared to take a deep breath hereafter." I think the teacher should not take a deep breath unless the pupil will thereby learn more algebra than if the teacher had taken a short breath.

131. Locus versus Function. There are two distinct concepts which a pupil should have about the graph of an equation, (1) the graph is a locus of points, and (2) the graph is a picture



which shows the changes in a function when the independent variable changes. In the first case the emphasis is on certain points and our attention should be focused on those points. In the second case the emphasis is on the length of certain ordinates.

I doubt if we should try to teach both ideas in the ninth grade; or, if we do, the ideas should be separated by a sufficient interval

of time so that one concept will be fully settled before the second enters. Since the function concept is popular in pedagogic circles, we usually develop the second one first. But the graphs that we ask the pupils to draw do not put the emphasis on the length of the ordinate. I have drawn two graphs as they should appear when we are studying the increase and decrease of the functions.

When developing this concept I try to prevent the pupil from plotting points. If $y=6$ when $x=2$ I want the pupil to place his piece of chalk on the x axis where $x=2$, and then to draw a heavy line upward or downward until it is the proper length using the scale on the y axis as a guide. The pupil should not mark a point at the end of the ordinate. The questions by the teacher should emphasize the length of the ordinate: How long is the line when $x=2$? Do the lines become longer or shorter when x increases? For what values of x are the lines negative?

THE PACIFIC CHEMICAL EXPOSITION

"The supply of chemists and chemical engineers is keeping step with industrial growth in the Pacific area," says Paul Williams, chairman of the exposition committee for the Pacific Chemical Exposition. Between 1940 and 1946, in terms of manufacturing wage earners, some California industries have shown the following percentage growth: glass and glassware, 120%; rubber products, 127%; electrical machinery and equipment, 152%; machinery (except electrical), 118%; beet sugar processing, 95%; while during the same period the California Section of the American Chemical Society, which takes in only the San Francisco area, increased 125% to a total of 1,540 members.

Particular attention is being focused now on the Northwest in the fields of electrochemistry, pulp and paper and chemurgic products where the electrical energy consumption for these industries has increased 600%, according to Mr. Williams, while groups in other parts of the west are concentrating on potash for fertilizers and flotation agents, steel, soda ash, petroleum, blood processing, plastics, citrus by-products, biologicals, rubber, magnesium, calt and the halogens, to mention but a few.

TINCTURE OF IODINE HAS STING REMOVED

Pharmacists are going to take the sting out of tincture of iodine, a famous disinfectant for cuts for more than a century.

The new edition of the Pharmacopoeia of the United States of America which will become official April 1, 1947, has dropped the familiar 7% tincture of iodine in favor of a 2% mild tincture. Just as efficient as an antiseptic and germicide, the milder tincture has the advantage of not retarding healing by destroying tissue, a frequent fault of the stronger remedy.

The Committee of Revision of the Pharmacopoeia declares, "Every druggist in the country should be familiar with this change." You will agree if you recall the sting of the old iodine disinfectant.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS REPORT OF THE DETROIT MEETING

The Detroit convention more than met the high standards that have been set by the Association in the last few annual meetings. The only complaint heard in the corridors of the Book-Cadillac hotel was to the effect that there was too much to see and hear in the time available. No attempt will be made to cover the convention in detail. A *Yearbook* was sent to each member of the Association and the program as outlined in it was executed with efficiency and thoroughness. The many teachers in Detroit who acted as hosts to those who attended deserve praise and thanks. Allen Meyer and Emil Massey had a tremendous amount of cooperation.

A number of the papers presented at the various meetings will appear in the official journal, SCHOOL SCIENCE AND MATHEMATICS. Dr. Perrine's demonstration lecture, the General Motors luncheon demonstration and the Saturday trip to the Rouge plant of the Ford Motor Company were highlights which will not be written up but which will and have been told in detail to thousands of students in the science and mathematics classrooms in the middle west. Teachers who attend conventions such as this are stimulated to do more enthusiastic work and to have wider perspective from which to present materials. Our hats off to the Detroit teachers who so splendidly came through.

MINUTES OF THE MEETINGS OF THE BOARD OF DIRECTORS

Those present were: President A. O. Baker, Vice-President Charlotte Grant, Secretary Harold H. Metcalf, Treasurer Ray C. Soliday, Historian Edwin W. Schreiber, Walter Carnahan, Herschel E. Grime, George E. Hawkins, Ruth W. Mikesell, Paul L. Trump, Kenneth Vordenberg, Fred D. Leonhard, Mary A. Potter, J. E. Potzger, Bjarne R. Ullsvik, and Fred W. Moore.

President Baker called the first meeting to order at 4:30 P.M.

Fred D. Leonhard, chairman of the membership committee gave credit to the various members of his committee for the healthy condition of the Association. The mimeographed report which he distributed showed on all time high of 1227 members located in 45 states and in foreign countries. By sections the membership was distributed as follows: Biology—16%, Chemistry—17.6%, Elementary Mathematics—3.2%, Elementary Science—3.75%, General Science—10.7%, Mathematics—40%, Physics—18.5%, Geography—2.1% and others not classified—9.8%.

Six hundred members and 142 guests registered at the convention on Friday.

Walter H. Carnahan, chairman of the committee on by-laws, stated that there seemed to be no immediate need for revision.

Paul Trump presented the report of the policy committee. The written report is included in the secretary's book which contains a complete record of the business of the Board of Directors. Bjarne Ullvsik moved, J. E. Potzger seconded and it was passed that the present policy committee

continue to be active through the spring meeting at which time more consideration would be given to the implementation of the report.

President A. O. Baker, who was himself given much credit for the success of the convention, personally called Allen Meyer, chairman of the local arrangements committee, before the Board of Directors to thank him for the splendid work the Detroiters had done. Mr. Baker also expressed warm appreciation to Fred Leonhard and to Mrs. Geraldine Reep Johnson and to all others who had cooperated and helped.

A rather lengthy discussion ensued regarding the date of the founding of the Association and the year in which the 50th anniversary should be celebrated. The committee report on an Anniversary Publication is included as an appendix at the end of this report as a matter for record.

Charlotte Grant moved, Ruth Miksell seconded, and it was passed that the fiftieth anniversary of the Central Association of Science and Mathematics Teachers be celebrated in the convention year of 1950.

Charlotte Grant moved, Kenneth Vordenberg seconded and it was passed that the incoming president appoint a committee to further study the idea of the publication of an anniversary memento. The committee is to report at the spring meeting.

Marie S. Wilcox, chairman of the place of meeting committee reported that hotel facilities would be at a premium in November of 1947 and suggested that the Board of Directors immediately contact the Edgewater Beach Hotel in Chicago for accommodations and also decide to go to Indianapolis in 1948 if space is available.

Edwin Schreiber moved, Kenneth Vordenberg seconded and it was passed that the 1947 convention be held in Chicago and that the Edgewater Beach Hotel be wired at once for convention space.

Miss Potter moved, Mr. Schreiber seconded and it was passed that Indianapolis be tentatively chosen as the 1948 convention city and that Mrs. Wilcox tentatively reserve hotel space for the convention.

Mr. Peterson gave the report for the journal committee. He pointed out that in the fiscal year July 1, 1945 to June 30, 1946 income of the Association increased $1170.66 over the budget provision and that expense decreased $40.75 leaving a net income from operations of $1211.41. This was in large part due to the large return from the Yearbook and from the sale of back issues.

Mr. Soliday presented a written statement of the present condition of the Association accounts and of the problems of back issues and of increasing printing costs. He recommended reprinting by the offset process of two back issues to make complete sets of SCHOOL SCIENCE AND MATHEMATICS available for sale.

Mr. Peterson moved, Mr. Schreiber seconded and it was passed that Mr. Soliday contract for the printing of the two back issues in question, that other back issues be reprinted as they become exhausted providing demand is sufficient and executive committee authorizes.

Mrs. Johnson gave the *Yearbook* report. Additional printing costs reduced the net income to the point where it is questionable whether costs will be covered. The printing bill had not yet been presented in its final form and Mrs. Johnson asked for advice on procedure. The following motion covered the contingency.

Mrs. Mikesell moved, Mr. Vordenberg seconded and it was passed that Mrs. Johnson pay all *Yearbook* costs except the printing bill, that she turn the balance of the receipts over to the Association treasurer, and that the Association treasurer pay the printing bill when it is received.

At the suggestion of the Journal Committee, the following motion was made by Miss Grant, seconded by Miss Potter and passed that the ad-

vertising rates in the *Yearbook* be increased to the following: double page, \$70.00; 1 full page, \$40; 1 half page, \$25. These rates are subject to revision at the spring Board meeting.

Mr. Warner, editor of SCHOOL SCIENCE AND MATHEMATICS, reported that manuscripts were still not coming in at the rate he desires. Some changes are taking place in the editorial staff. Mr. Warner urged that Board members attempt to increase the flow of manuscripts either by writing themselves or keeping their eyes open for material.

Mr. Schreiber moved, Mr. Trump seconded and it was passed that the following committee report be accepted:

The Central Association defines Honorary, Life and Emeritus members as follows:

Honorary memberships are granted in recognition of outstanding professional contributions made to the teaching of science and mathematics.

Life memberships are granted in recognition of outstanding service rendered to the Central Association of Science and Mathematics Teachers.

Emeritus memberships are granted in recognition of 25 years of continuous membership in the Central Association of Science and Mathematics Teachers upon retirement from active teaching.

It is also recommended that the above statements be placed in the *Yearbook.*

Members of the committee which framed the definitions were Mrs. Geraldine Reep Johnson, Edwin W. Schreiber, Fred D. Leonhard, Ray C. Soliday and George K. Peterson, chairman.

The Emeritus membership was presented to the following by Mr. Peterson at the morning session November 29, 1946:

O. D. Frank, University of Chicago
E. E. Burns, formerly of Austin High School, Chicago
Edith Irene Atkin, State Normal University, Normal Illinois

Others who were voted the Emeritus membership but were not present to receive it were:

Warren Rufus Smith, Passe a Grill Beach, Florida
B. S. Hopkins, University of Illinois
J. M. Kinney, Wilson Junior College, Chicago
Jerome Isenbarger, Wright Junior College, Chicago
Katherine Isenbarger, Chicago

It was moved, seconded and passed that each out of town member of the Board of Directors attending the spring Board meeting shall be paid round trip coach fare plus \$5 expense money.

The meeting was adjourned.

THE SATURDAY MORNING BUSINESS SESSION

Mr. Trump moved, Mr. Massey seconded and it was passed that the following report of the Resolutions Committee be adopted:

The committee on resolution wishes to offer for the consideration of the Association the following resolutions:

1. That continuity of membership on the resolutions committee be provided by instructing the new president each year to appoint two members for three year terms at the beginning of his term of office and also to appoint the chairman of the committee for the ensuing year. The president is to appoint the first six members in 1946–47 and designate their terms of office.

2. That the resolutions committee shall have the duty of proposing actions that the Association may take to further the program of science and

mathematics teaching in the schools. For example, what can the Association do to bring about desired changes in the curriculum?

3. That, since the recruitment and training of young teachers presents an immediate and serious problem, the Association consider ways in which it can assist in a solution.

Respectfully submitted,
ENOCH D. BURTON
IRA C. DAVIS
FRANKLIN FREY
GEORGE E. HAWKINS, *chairman.*

NOTE: The resolutions committee and the policy committee may become a single committee. Board study and action on this matter will be considered at the spring meeting of the Board of Directors.

Mr. Soliday, business manager of the JOURNAL, reported that the trends in Association membership and in JOURNAL circulation were upward. Increased printing costs must be met by additional subscriptions and memberships or by increasing the membership fee.

President Arthur O. Baker paid special tribute to Allen Meyer, C. J. Leonard, Emil Massey, Dorothy Tryon, Lydia Elzey and other Detroiters who helped make the convention a success.

Mr. Glen Warner gave the necrology report and the members present stood for a minute in silent tribute to those who had passed on. Those deceased included Wm. L. Fenner of Hirsch High School, Chicago; Louis W. Caldwell, Sullivan High School, Chicago; Carl C. Miller, South Bend; Edna C. Battin, Colton Union High School, Colton, California, and A. P. Carman, Honorary Member, University of Illinois.

George K. Peterson gave the report of the JOURNAL Committee which is covered in the minutes of the Friday meeting.

Mrs. Wilcox reported for the Place of Meeting Committee. She told of the action which the Board of Directors had taken in the Friday meeting.

Mrs. Johnson gave the *Yearbook* report. She stated that 6000 copies were printed and that, because of increased printing costs, a deficit of 85 to 100 dollars was ancitipated. She thanked the various members who had helped with the exhibits.

Mr. Fred Leonhard reported 1227 members in the Association and thanked the various members of his committee for their hard work and cooperation.

Mr. Edwin Schreiber told briefly of the 50th anniversary meeting of the Association which will be held in Chicago. He stated that he had all *Yearbooks* from 1902 to present except the 1921 issue. He hopes that some one will mail him a copy.

Mr. Emil Massey gave the report for the Nominating Committee as follows:

President: George E. Hawkins, Lyons Twshp. Jr. College, LaGrange, Ill.
Vice-president: J. E. Potzger, Butler University, Indianapolis.
Board of Directors:
One year to replace J. E. Potzger—Allen F. Meyer, Detroit.
Three years, F. Olin Capps, Missouri Conservation Commission
Charlotte Grant, Oak Park Twshp. H. S., Oak Park, Ill.
Walter N. Smith, East Tech. H. S., Cleveland
Paul Trump, University of Wisconsin.

Mrs. Johnson moved, Mr. Vordenberg seconded and it was passed that a unanimous ballot be cast for the officers.

Mr. Hawkins, the newly elected president, was called upon for remarks.

Mr. Walter Carnahan, the 1944–45 president, spoke warmly of the

splendid work of Arthur O. Baker. The presidency of the Central Association calls for great expenditures of energy and effort; it calls for organizing capacity; and it calls for an understanding of how to work with and get along with people. Mr. Baker deserves great commendation for his contributions to the continued growth and well being of the Central Association of Science and Mathematics Teachers. Those present heartily concurred.

The meeting was adjourned.

THE SATURDAY AFTERNOON MEETING OF THE BOARD

Mr. Baker informed the Board that the expense incurred by the Local Arrangements Committee exceeded the budget allowance for that group, while costs for the convention speakers were under the budget. Approval was requested to transfer funds from the one item to the other, to cover the excess expenditures without exceeding the total sum allowed for both. Board approval of this step was moved and carried.

Mr. Baker recommended that the Treasurer be authorized to pay any nominal incidental bills which might be presented by the hotel during a final audit of their account with the Association. It was moved and carried that such payments be authorized. (Mr. Meyer has sent a receipted bill from the hotel for all expense.)

There being no further old business, the meeting was turned over by Mr. Baker to the president-elect, George Hawkins.

Mr. Hawkins informed the Board that Secretary Harold H. Metcalf desired to be relieved from his duties as Secretary, although he was willing to serve to the time of the spring meeting. It was moved by Mr. Trump, seconded by Miss Potter and carried that George K. Peterson be elected as Secretary to succeed Mr. Metcalf.

Mr. Hawkins asked everyone to give him suggestions, ideas and recommendations for the next convention program and for the Association management. He stated that the spring Board meeting be held at the Edgewater Beach Hotel in Chicago on the second Saturday in May, May 10, and that there be three sessions, forenoon, afternoon and evening. Coach fare plus $5 will be paid each officer on the Board of Directors who comes to the meeting from out of town.

Mr. Hawkins advised the Board that there would be two vacancies on the Journal Committee to be filled by appointment, with approval by the Board.

The meeting was adjourned. This meeting was unique in that it was conducted aboard bus on the trip to the Rouge plant.

The minutes of the three meetings are respectfully submitted.

HAROLD H. METCALF, *secretary.*

THE SECTION MEETINGS

The various section meetings of the Association held on Friday afternoon and on Saturday morning met the high standards established in the general meetings. As many papers as are available will be presented in the Journal SCHOOL SCIENCE AND MATHEMATICS. The 1946 *Yearbook* may be used as a source of information relating to the various meetings. If more definite information is desired, please write to me or to the chairman of the meeting in question. Officers for the sections were elected in accordance with the by-laws of the Central Association of Science and Mathematics Teachers. The full roster of officers for 1946–47 appears in this issue of the JOURNAL.

HAROLD H. METCALF, *secretary.*

CENTRAL ASSOCIATION
of
SCIENCE AND MATHEMATICS TEACHERS

Report of
Business Manager & Treasurer
27 November 1946

1. *Financial Condition*

Our Association was fortunate financially during the fiscal year ended 30 June 1946. Summaries in the auditor's report show:

	Budget	*Actual*
Receipts	$10,340.00	$11,510.66
Expenditures	10,340.00	10,299.25
Net gain from operations		$1,211.41

Cash resources on 26 November 1946 are:

Cash in bank	$5,558.14
Gov't bonds	2,148.00
Total	$7,706.14

Improvement in cash resources during recent years has been substantial:

1 July 1943	$2,633.20
22 Nov. 1945	6,372.92
26 Nov. 1946	7,706.14

During the current fiscal year, 1 July through 26 November, we have

Received	$4,610.41
Expended	3,281.79

2. *Journal Circulation*

The moderate improvement in JOURNAL circulation reported a year ago has continued, as represented by the mailing list count for December issues:

December 1942	2,325
December 1943	2,661
December 1944	2,615
December 1945	2,912
December 1946	3,186

At present, about 40% of all JOURNALS mailed out go to Central Association members. This is probably an all-time high proportion of members to other subscribers.

REPORT OF POLICY COMMITTEE

It is the judgment of your committee that the Board of Directors as constituted was meant to be and should be the policy forming group of the association. In order that that Board be able to function more effectively in this capacity, the committee submits to the Board several recommendations. These recommendations have been prepared to meet two major aspects of the situation which have seemed to restrict the Board's effectiveness in this capacity. The first develops from the fact that certain details of management, particularly in connection with convention planning, have required too great a portion of the Board's time while in session. The second stems from the fact of annual changes in the executive committee. This lack of continuity plus the many management problems each new executive committee faces makes very difficult their exercise of leadership in building up constructive long term policies.

Recognizing these problems, the committee on resolutions at the 1945 convention submitted a resolution asking ror the creation of a Policy Committee of the Board. Our President, in November 1946 asked the undersigned to constitute this committee and bring in a report to the Board. We therefore, offer this report and make the following recommendations.

1. The policy committee of three shall be continued, the president for the year 1945–46 shall appoint the committee for the year 1946–47 stipulating its chairman and the term of office, one for one year and one for two years and one for three years, that each subsequent president shall appoint one association member for a three year term as a replacement including the possibility that a retiring member may succeed himself and that at the time of such appointment the president may designate the chairman for the coming year. For other vacancies, appointment shall be for the unexpired term. All such appointments shall be subject to the approval of the Board.
2. Members of the policy committee who are not Board members shall serve as members of the Board ex-officio.
3. The policy committee shall meet with the executive committee at least once during the year at an another time than those set for the regular meetings of the Board, such meeting to be at the call of the President.
4. It shall be the duty of the Policy Committee to prepare agenda, to assemble pertinent information for discussion and to make recommendation for action to the Board of Directors on matter pertaining to policy.
5. The Policy Committee shall be responsible for consideration and suggestions to the Board for action on matters included in resolutions adopted by the association upon recommendation of the Resolution Committee.
6. In order to provide increased time for the Board in which matters of policy may be presented and properly considered, convention committees will report at special meetings of the Executive Committees which committee will report to the Board on items of information which in their judgment the Board should have, and on matters needing Board action. At the discretion of the Executive Committee, the General Chairman of Local Arrangements Committees may report to the Board.
7. Association Committees shall submit written reports to the Executive Committee copies of which shall be made available to Board members. The Executive Committee will exercise its discretion in calling the chairman of such committees before the Board.

Respectfully submitted,
GEO. E. HAWKINS
KENNETH E. VORDENBERG
PAUL L. TRUMP, *chairman.*

REPORT OF THE COMMITTEE ON ANNIVERSARY PUBLICATION

The Committee: Pauline Royt, Milwaukee; Mary A. Potter, Racine; Walter H. Carnahan, Chairman, Lafayette.

The matter of the publication of a volume distinct from an issue of the JOURNAL is in the nature of a major departure for C.A.S.M.T. and the Committee believes that deliberation is in order. However, since the time is somewhat limited and the work to be done if an affirmative decision is reached is very great, we believe that the work of investigation and study should not be allowed to lag.

The Committee makes the following recommendations more in order to get discussion by the Board than to get their acceptance as the basis of action. At present they represent the best ideas of the committee, either as unanimous opinions or as a fair compromise.

Recommendations of the Committee

1. *Publication recommended.* We recommend that an anniversary publication be issued in 1950. (1951?)

2. *Type of publication.* We recommend that this publication be a bound volume distinct from the Journal with emphasis on quality rather than size.

3. *Editorship.* We recommend that this publication be under the editorial direction of an editor selected for this responsibility alone but that there be an editorial committee appointed to give all possible aid to the editor and that the editor of the Journal be a member of the Committee. We recommend that the editor-in-chief of the anniversary publication be assisted by departmental editors representing mathematics and the various sciences.

4. *Business management.* We recommend that business management of the publication be in the hands of the business manager of C.A.S.M.T. but that he be permitted to recommend to the Board a person or persons to assist in the venture if he wishes.

5. *Contents of the publication.* We recommend that the publication deal briefly and concisely with the development of science and mathematics over a period of fifty years in research, teaching methods, organization, equipment, changes of emphasis, influences from abroad, effects of prosperity, depression, war, and social changes. We recommend an introductory chapter that will give an over all view of changes, to be followed by chapters on mathematics, physics, geography, chemistry, biology and general science which will give detailed pictures of developments and perhaps evaluate the trends and give to education some sense of direction for the future. There might well be included a brief survey of outstanding articles that have appeared in the Journal during the part of its life as official organ of C.A.S.M.T.

6. *Name of the publication.* A name descriptive of the nature and purpose of the publication should be chosen. This should be brief, dignified and capable of catching interest. It might be *Monographs on Science and Mathematics*, or *Association Monographs*, or *Fifty Years of Mathematics and Science*, or *Golden Jubilee Monographs*, or *The Gold Book*, or *Central Association Gold Book*, or *Fifty Years of Teaching Mathematics and The Sciences.*

7. *History of C.A.S.M.T.* We have considered the matter of a history of our organization and agree that one should be prepared and published. This might be a chapter of the anniversary publication, or it might be a separate booklet, or it might be issued as a number or part of a number of the Journal.

8. *Sequence of books.* We recommend that the anniversary publication be prepared without reference to other possible books to follow. The success of this publication would naturally enter into any decision to publish or not to publish other books. If the Board deems it advisable to look definitely to a sequence of such volumes, it is recommended that provision be made for a planning committee to study sequential considerations so that the series may be unified.

9. *Selection of editors and writers.* Since the editing and writing will be done by persons with other heavy responsibilities, we recommend that the Board make a decision as to publication as soon as possible and proceed to set up the organization without delay.

10. *Pay for editors and writers.* We recommend that persons be asked to assume duties of editing and writing without remuneration. However, provision should be made to pay limited necessary expenses for travel and clerical help on the same basis as for Board meetings. Decision as to what are necessary expenses should rest with the Board. A budget should be set up to provide for these expenses, this budget to be administered by the Board.

11. *Illustrations.* The publication should be adequately illustrated. So far as possible, illustrations should be evenly distributed among the various articles so as to give balance to the volume.

12. *Shared responsibility.* We recommend that C.A.S.M.T. carry sole responsibility for publication without aid from any university, scientific organization, foundation or commercial company.

13. *Announcement.* We believe that announcement of the publication should be made as soon as possible after a decision has been reached assuming that this decision is an affirmative one.

14. *Subscriptions.* We believe that no subscriptions should be solicited nor received at this time.

15. *Termination of this committee.* We believe that this committee has carried out the assignment given to it by the Board and that it should now cease to exist.

LARGEST U. S. SPHERICAL ROLLER BEARINGS IN PAPER-FINISHING MACHINE

Two spherical roller bearings, which together will weigh five tons when assembled and will be the largest ever built in the United States, are under construction at SKF Industries, Inc., Philadelphia. They are for use in a paper-mill calender machine that gives high-quality paper a fine finish as it passes between rollers under very high pressure.

Modern machinery of all sorts now employs some type of ball or roller bearings are relatively small and are machined with great accuracy. The hard metal balls used are said to be the most perfect spheres produced in industry.

The forgings which will become the inner rings of the giant bearings are four feet in diameter, and each will support 38 rollers weighing 35 pounds apiece. Each bearing is designed to carry a load in excess of 2,000 tons. The calender will have 18 other spherical roller bearings, all large but lighter and smaller than these two

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RECONDITIONER FOR PAVEMENT MATERIAL

With thousands of miles of war-worn and neglected highway and street pavements to be replaced, more than usual interest attaches to a steam reconditioner for bituminous binder material, making possible the re-use of old surfacings.

It is of quite simple construction, consisting of a sealed hopper containing a superposed series of perforated steam pipes in grid-like patterns. The broken-up pavement material is thrown into this and the steam, at fairly high pressure and temperature, digests the bituminous binder out of the mass. At the same time, new pavement materials are added. Preliminary analyses are necessary to determine the needs for each stretch of road.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1999, 2001, 2, 4. *Francis L. Miksa, Aurora, Ill.*

1999, 2000, 1, 2, 3. *C. W. Trigg, Los Angeles City College.*

2000, 1, 2. *Hugo Brandt, Chicago.*

1999, 2001. *Paul Mount-Campbell, New Mexico Military Academy*

2000, 1. *Philip Rosenblatt, Brooklyn, N. Y.*

1996, 2002, 3. *M. Kirk, Norristown, Pa.*

1995. *L. R. Galebaugh, Lebanon, Pa.*

2001. *Mildred Hopkins, Kankakee, Ill.*

A LATE SOLUTION

1992. *Proposed by Howard D. Grossman, New York City.*

Solve $x^2-2=y$, $y^2-2=z$, $z^2-2=w$, $w^2-2=x$.

Solution by the Proposer

This system reduces to a 16th degree equation in any of the unknowns and has therefore 16 sets of answers; the assumption $x=2\cos t$ gives all of them. If $x=2\cos t$, $y=4\cos^2 t-2=2\cos 2t$, $z=2\cos 4t$, $w=2\cos 8t$, $x=2\cos 16t=2\cos t$. Then either $15t$ or $17t=0, 2\pi, 4\pi$, etc. Solving, simplifying, and eliminating duplications:

$x, y, z, w =$

2, 2, 2, 2 (one solution);

$-1, -1, -1, -1$ (one solution);

$2\cos 2\pi/15, 2\cos 4\pi/15, 2\cos 8\pi/15, 2\cos 16\pi/15$ (4 solutions in cyclical order);

$2\cos 2\pi/5, 2\cos 4\pi/5, 2\cos 2\pi/5, 2\cos 4\pi/5$ (2 solutions in cyclical order);

$2\cos 2\pi/17, 2\cos 4\pi/17, 2\cos 8\pi/17, 2\cos 16\pi/17$ (4 solutions in cyclical order);

$2\cos 6\pi/17, 2\cos 12\pi/17, 2\cos 10\pi/17, 2\cos 14\pi/17$ (4 solutions in cyclical order).

Walter R. Warne, Dayton, Ohio, and Rex E. Harvey, Elkhart, Ind. also offered solutions.

2005. *Proposed by Luella Boehncin, New York City*

Solve for x: $\sqrt{x-1}+\sqrt{x}=\sqrt{x+1}$.

Clarence R. Perisho, McCook, Neb., offers the following:

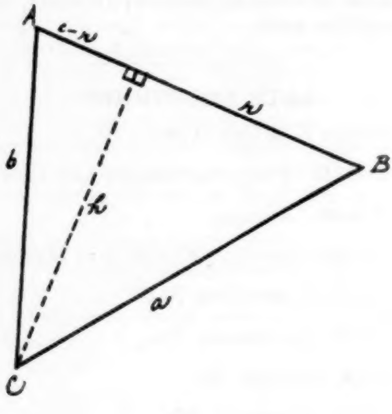
By trial and error and with the use of a seven-place table of logarithms, the real root is found to lie between 1.020791 and 1.020792.

Another similar solution was offered by Rex E. Harvey, Elkhart, Ind.

2006. *Proposed by Grace Marsh, Mexico City, D. F.*

In any plane triangle ABC, if $\tan A = 2 \tan B$, show that $3a^2 = 3b^2 + c^2$

Solution by Joseph Lerner, Roxbury, Mass.



$$\tan A = \frac{h}{c-r}$$

$$\tan B = \frac{h}{r}$$

$$\frac{h}{c-r} = \frac{2h}{r}$$

simplifying—

$$3r = 2c.$$

From law of cosines—

$$a^2=b^2+c^2-2bc\cos A$$

$$3a^2=3b^2+3c^2-6bc\cos A$$

$$\cos A=\frac{c-r}{b}$$

$$3a^2=3b^2+3c^2-6c^2+6cr.$$

Substituting $3r=2c$

$$3a^2=3b^2+c^2$$

Solutions were also offered by Clarence R. Perisho, McCook, Neb.; Walter R. Warne, Dayton, Ohio; Grace Marsh, Mexico, D. F.; Theodore Marsh, Fredericksburg, Va.; Francis L. Miksa, Aurora, Ill.; Margaret D. Zwisky, Oak Park, Ill.; Aaron Buchman, Buffalo, N. Y.; Margaret Joseph, Milwaukee, Wis.; C. N. Mills, Normal, Ill.; Felix John, Philadelphia, Pa.; C. W. Trigg, Los Angeles City College; Helen M. Scott, Baltimore, Md.; M. Kirk, Norristown, Pa.; Hazel G. Wilson, Annapolis, Md.; Mildred Hopkins, Kankakee, Ill.; Philip Rosenblatt, Brooklyn, N. Y.

2007. *Proposed by Hugo Brandt, Chicago, Ill.*

The limit of regulation size of an overseas package is 42″ for "length plus girth." Compute the maximum contents of such package if its shape is (a) box like, (b) cylindrical.

Solution by C. W. Trigg, Los Angeles City College

(a) For any particular girth the maximum cross-sectional area will be enclosed by a square of side, say x. Then the length will be $42-4x$.

$$V=(42-4x)x^2.$$

$$\frac{dV}{dx}=84x-12x^2.$$

Hence the minimum volume will be attained for $x=0$, and for $x=7$, a maximum volume of 686 cu. in. will be secured.

(b) If the radius of the cylinder be r, the length will be $42-2\pi r$.

$$V=(42-2\pi r)\pi r^2.$$

$$\frac{dV}{dr}=84\pi r-6\pi^2 r^2.$$

Hence the minimum volume will be given by $r=0$, and $r=14/\pi$ will give a maximum volume of $2744/\pi$ cu. in. or approximately 873.44 cu. in.

Other solutions were offered by Francis L. Miksa, Aurora, Ill.; Philip Rosenblatt, Brooklyn, N. Y.; Clarence R. Perisho, McCook, Neb.; Felix John, Philadelphia, Pa.; Helen M. Scott, Baltimore, Md.; M. Kirk, Norristown, Pa.; Hazel S. Wilson, Annapolis; Hugo Brandt, Chicago.

2008. *Proposed by Howard D. Grossman, New York City*

In triangle ABC, $B=C=80°$. Select D on AB and E on AC so that $\angle CBE=50°$ and $\angle BCD=60°$. Prove by plane geometry that $\angle CDE=30°$.

Solution by Aaron Buchman, Buffalo, N. Y.

Take point F on AB so that $\angle BCF=20°$. Draw FE.

In triangle BEC, $\angle BCE=80°$, $\angle EBC=50°$, and $\angle BEC=50°$. Then

$$BC=EC. \tag{1}$$

In triangle BCF, $\angle BCF=20°$, $\angle FBC=80°$, and $\angle BFC=80°$. Then

$$BC=FC. \tag{2}$$

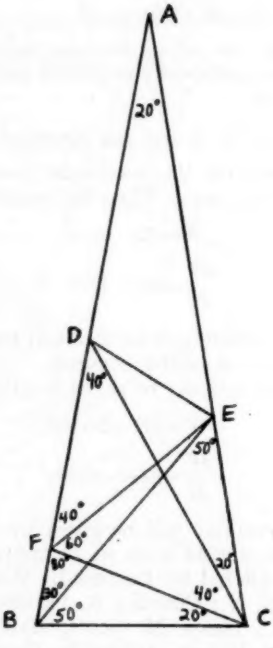
But $\angle FCE=60°$, and from (1) and (2) $EC=FC$.
Then triangle FCE is equilateral and

$$FE=FC=EC. \tag{3}$$

Now in triangle BCD, $\angle DBC=80°$, $\angle BCD=60°$, and $\angle BDC=40°$.
Therefore, in triangle DFC, $\angle FCD=\angle FDC=40°$ and

$$FD=FC. \tag{4}$$

From (3) and (4), $FD=FE$ and triangle DFE is isosceles.
Since $\angle BFC=80°$ and $\angle CFE=60°$, then in isosceles triangle DFE, vertex angle $DFE=40°$.
Therefore base angle $FDE=70°$.
Then $\angle CDE=30°$.



Solutions were also offered by Norman Anning, University of Michigan; Francis L. Miksa, Aurora, Ill.; Israel Wallast, Brooklyn, N. Y.; Helen M. Scott, Baltimore, Md.; Joseph Lerner, Roxbury, Mass.

2009. *Proposed by Norman Anning, University of Michigan.*

A stone falls freely from the top of a house to the ground. If it falls the last nth of the height in $1/n$ of a second, show that the house is not more than 65 feet high.

Solution by C. N. Mills, I.S.N.U., Normal, Ill.

Let s = the total distance fallen in feet. Then s/n = the last distance fallen.

Let t = the time to fall the total distance.

Let t_1 = the time to fall the last distance. Then time to fall s feet $=\sqrt{2s/g}$. Also

$$\text{time to fall } s\left(1-\frac{1}{n}\right) \text{ feet} = \sqrt{\frac{2s}{g}\left(1-\frac{1}{n}\right)}.$$

$$\sqrt{\frac{2s}{g}}-\sqrt{\frac{2s}{g}\left(1-\frac{1}{n}\right)}=\frac{1}{n}.$$

Reducing this radical equation gives

$$\sqrt{2s}=\sqrt{g}\left[1\pm\sqrt{1-\frac{1}{n}}\right].$$

The maximum value of $\sqrt{1-1/n}$ is unity.

Therefore $\sqrt{2s}=2\sqrt{g}$, or $s=2g$.

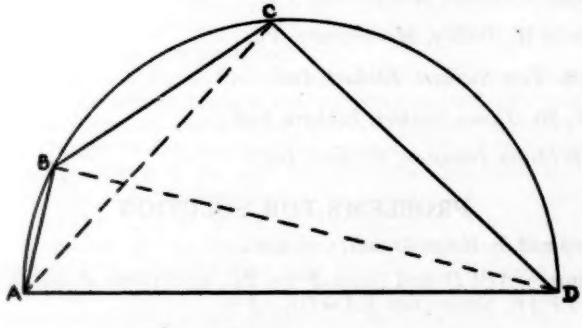
Solutions were also offered by Aaron Buchman, Buffalo, N. Y.; Charles W. Trigg, Los Angeles City College; Francis L. Miksa, Aurora, Ill.; M. Kirk, Norristown, Pa.; Robert Kissling, Redlands, Calif.; Helen M. Scott, Baltimore, Md.; Philip Rosenblatt, Brooklyn, N. Y.

2010. *Proposed by Isadore Gosz, West DePere, Wis.*

Three consecutive chords of a circle whose lengths are 1, 2, and 3, respectively, subtend a semicircle. Find the diameter of the circle.

Solution by the Proposer

Let chords $AB=1$, $BC=2$, and $CD=3$: let the diameter $AD=x$, and draw diagonals AC and DB.



By a property of cyclic quadrilaterals

$$AC\times BD=AD\times BC+AB\times CD$$

$$(1) \qquad \therefore \quad AC\times BD=2x+3.$$

But since $ABCD$ is a semicircle, the angles ABD and ACD are right angles,

$$\therefore \quad AC=\sqrt{x^2-9}; \qquad DB=\sqrt{x^2-1}.$$

Substituting in (1) we obtain:

$$\sqrt{x^2-9}\times\sqrt{x^2-1}=2x+3$$
$$x^4-14x^2-12x=0.$$

This equation has only one positive root: $x=4.1133$.

Other solutions were offered by Harold Venske, Santa Ynez, Calif.; Mildred Hopkins, Kankakee, Ill.; Helen M. Scott, Baltimore, Md.; C. W. Trigg, Los Angeles; Clarence R. Perisho, McCook, Neb.; C. N. Mills, Normal, Ill.; L. R. Galebaugh, Lebanon, Pa.; Francis L. Miksa, Aurora, Ill.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

For this issue the Honor Roll appears below.

1988, 2006. *Bill Holston, Mercersburg, Academy.*

1990. *Charles Queenan, Mercersburg, Academy.*

2006. *Carl G. Markel, Mercersburg, Academy.*

1995. *Bob Melville, Fort Myers, Fla.*

2003. *Eugene Holt, Mason City, Ia.*

1990. *Bill Lawrence, Mercersburg, Pa.*

1995, 2006. *Joseph Mulson, Mercersburg, Pa.*

1990. *Edgar Masinter, Mercersburg, Pa.*

2010. *Edwin W. Bailey, Mercersburg, Pa.*

1992, 2010. *Tom Swihart, Elkhart, Ind.*

2006, 7, 9, 10. *James Grabiel, Elkhart, Ind.*

2006, 7. *William Johnston, Elkhart, Ind.*

PROBLEMS FOR SOLUTION

2023. *Proposed by Hugo Brandt, Chicago*

In a square $ABCD$ find point F on BC, and point E on DC so that $\angle BAF=\angle FAE$. Show that $EA=DE+FB$.

2024. *Proposed by L. Jacobus, Kinderbook, N. Y.*

If in triangle ABC, $(a^2+b^2)\cos 2A=b^2-a^2$, show that the triangle is right angled.

2025. *Proposed by D. F. Wallace, St. Paul, Minn.*

If n is an even integer such that $n/2$ is the product of an odd number of

twos and an odd number, then there is no square equal to the sum of n consecutive integers.

2026. *Proposed by Mildred Bitner, Brunswick, Me.*

The equation $x^5-209x+56=0$ has two roots whose product is unity. Find them.

2027. *Proposed by Charles King, Philadelphia, Pa.*

Solve:

$$(x+y)(x+z)=30$$
$$(y+z)(y+x)=15$$
$$(z+x)(z+y)=18$$

2028. *Proposed by Orville F. Barcus, Philadelphia, Pa.*

Through a given point within an angle, construct a circle tangent to two sides of the angle.

BOOK REVIEWS

BIOLOGY FOR YOU, by B. B. Vance, *the Science Department, Kiser High School,* and *Assistant Professor of Biology and Education, The University of Dayton;* and D. F. Miller, *Professor of Zoology, Supervisor of Teacher Training in Biological Sciences, The Ohio State University.* Cloth. Pages vii+731. 16.5×23 cm. 550 illustrations. 1946. J. B. Lippincott Company, New York City, N. Y. Price $2.28.

The authors of this new testbook have apparently drawn upon their experience in teaching and teacher training to make this book unusually readable, attractive and useful. The numerous illustrations are particularly good for they clearly illustrate points brought out in the text. Most, if not all of them, have never appeared in texts before and a number are in full color. Naturally technical terms cannot and should not be completely avoided, but they are explained when first used and for completeness a 24-page glossary is added at the end of the book with simple definitions and a guide to their proper pronunciation.

There are fifteen units in the course which may be taken up as the teacher sees fit for each is more or less complete in itself. At the end of each unit is a Unit Summary and Review, several Problems in Scientific Thinking, a few Things To Do, and a supplementary list of Books You Might Enjoy Reading. A few of the unit headings may help give an idea of its scope. Beginning with Biology and Your Everyday Life, it goes on with The Insects, The Unseen World of Living Cells, How the Plants are Grouped, The Care of Our Bodies, The Next Generation, Conservation in the Present and Future, and ends with The Uses of Biology.

Many will be interested in the economic and practical aspects of the book. For instance, at the end of the unit on insects there is a very complete list of the injurious insects, the plants they attack and suggestions for their control. In the unit titled The Uses of Biology are given ideas on how to have a beautiful lawn and a successful garden. There is one table in the unit on The Care of Our Bodies which might well have been simplified for it gives too much detail on disease symptoms, prevention and cure. Besides the few items mentioned, there are numerous practical paragraphs in each unit which will relate the course in biology to the student's daily

life. In fact, just looking at the pictures and reading the explanations will give one an idea of its practicality.

If, then, you are looking for a biology text which will give freshness and added life to your biology course you will do well to consider this one. Its usefulness should commend it to many of your students as a reference book when they have completed your course.

HOWARD F. WRIGHT

THE WONDERWORLD OF SCIENCE, Book Nine, Science for a Better World, by Morris Meister, Ralph E. Keirstead and Lois M. Shoemaker. Cloth. vi+698 pages, 14×19.7 cm. 1946. Charles Scribner's Sons, New York, New York. Price $2.20.

This is the last and unquestionably the least of the popular Scribner's science series for grades 1–9. It is disappointing.

The book is undeniably up-to-date. It deals with plastics, radar, television, atomic energy, quinine synthesis—all the latest and most sensational topics. One can visualize its authors standing by a news-ticker, final page in hand, waiting for the latest word in new development. However, good teachers will not care for modernity if it is accomplished by mere superficiality.

Two chapters are liberally sprinkled with photographs of tinker-toy models of quinine, gasoline and chloroprene models. The text is as liberally sprinkled with words such as *butadiene* and *prontosil*. The book will have doubtful value to the larger percentage of boys and girls in most general science classes. All pupils would be benefitted by basic and more easily applied science.

Surprisingly, few suggestions for activities are scattered through the text. Those given do not encourage speculation and testing or conclusions; they are used to emphasize and "prove" statements made by the authors.

Each chapter closes with a page of additional suggestions for activities. In keeping with the book's de-emphasis of first-hand learning, most of the suggestions are for reading and reports.

Each chapter also ends with a set of questions. Many of these are sugar-coated with such childish devices as solving code-messages, inverting words and the like. Well taught science needs no sugar-coating—but perhaps the choice and treatment of subject matter in this book has made sugar-coating necessary.

WALTER A. THURBER

ELEMENTS OF MACHINES, by Frank L. Verwiebe, *Research Associate, Army Institute;* Elmer E. Burns, *Teacher of Physics (Emeritus), Austin High School, Chicago;* and Herbert C. Hazel, *Major, U. S. Marine Corps.* Cloth. Pages x+222. 15×23 cm. 1943. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y.

This book was originally written as a text for service men, but it is just as valuable today for students who can take only a limited course covering some of the fundamentals of mechanics and heat. Its authors are all men with many years of excellent teaching experience, men who know the subject thoroughly and are experts at presenting it. The text is divided into fourteen units consisting of from one to three short chapters each. This is followed by a 13-page section outlining sixty-three experiments for demonstration or student laboratory work.

To show the general plan of the book a discussion of *Unit Four-Simple Machines* follows. This explanation of the lever covers twelve pages with

fourteen diagrams, excellent descriptions, simple mathematical treatment that anyone with a knowledge of arithmetic can understand, a good set of nineteen questions on the material discussed, and eight excellent simple problems. Answers are given to four of them. The inclined plane, wedge, and screw are similarly treated in the next four pages, and the pulley with its modifications in gears and derricks covers another chapter of seven pages.

The service men with limited education who had a chance to use this book were very fortunate. Many others were tumbled into courses using texts too difficult for them. This book will continue to fill an important place in high school work in a country at peace.

G. W. W.

THE HERBAL OF WUFINUS, edited from the Unique Manuscript by Lynn Thorndike assisted by Francis S. Benjamin, Jr., Cloth, 476 pages, 15.4 ×23.7 cm. 1945. University of Chicago Press, Chicago, Illinois. $5.00.

This work of Rufinus in medieval Latin is written in a simple, straightforward style, almost in the manner of a textbook, and whatever difficulty of translation it presents is one of vocabulary. It contains many unusual words, and words quite unfamiliar to the student of classical Latin, but this only adds to its interest.

From the point of view of the information therein contained, it but further substantiates the sincere belief of the enthusiastic student of Latin and Greek and the civilizations they represent, that much of that which the twentieth century believes is its own discovery or creation had its beginning in classical antiquity and its development through the ages, and that we can profit greatly by an acquaintance with and an understanding of that heritage.

Rufinus' catalogue of plants reminds one of the names on the rows of bottles and jars in open view in an old apothecary shop and, of course, in the main are the same. However, one cannot read Rufinus without feeling that the author was a nature lover, genuinely interested in plants, with the desire to arouse a similar interest in his readers and to make their identification of plants easy. He gives careful descriptions of the appearance and distinguishing characteristics of plants and the names by which the different varieties were known in various localities, as well as a statement of their medicinal values.

This work treats of plants, their physical characteristics, and medicinal values, lists of ointments and waters, minerals, animals, and astronomy. Rufinus was not satisfied to pass on just his own knowledge of the many herbs listed, but he quotes from other authors. He declares that he applied all his ability to the bringing together from the works of great authors all knowledge and information about the qualities of herbs, and their effects upon human and animal life.

"Et colligam ex dictis sapientium antiquorum describendo virtutes herbarum et operationes earum in corporibus inferioribus secundum quod experimentati sunt et veritatem de ipsis invenire potuerunt. Et primo inducam dicta Diascoridis, secundo Circa instantis, tertio Macri, quarto Alexandri phylosophi, quinto Magistri Salerni, sexto Ysaac, septimo de Synonimis, dicam octavo." And I shall gather from the words of the learned men of earlier times, describing the qualities of herbs and their effects upon *inferior bodies* (human and animal life), next what they have tried out and the truth they have been able to discover about these very things. And so first I shall introduce the words of Diosicordes, in the second place Circa Instantis, third Macer, fourth the Philosopher Alexander, fifth the Master

Salernus, sixth Isaac, seventh from Synonyms, I shall speak (express my own opinion) in the eighth place.

I cannot judge the value of this book to science or medicine, but certainly it should be of great value and interest to anyone interested in the history of botany, or even of medicine.

May I recommend Mr. Thorndike's own introduction to his book as a most thorough, painstaking, and detailed review of its contents.

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TABLE OF ARC SIN X, Prepared by the Mathematical Tables Project, Conducted under the Sponsorship of the National Bureau of Standards. Present Volume begun under the Auspices of the Work Projects Administration for the City of New York and Completed with the Support of the Office of Scientific Research and Development. Lyman J. Briggs, *Director, National Bureau of Standards, Official Sponsor;* and Arnold N. Lowan, *Project Director*, Mathematical Tables Project. Cloth. Pages xix+124. 18×26.5 cm. Columbia University Press, New York, N. Y. Price $3.50.

These tables have been prepared for values of x from 0 to $\pi/2$, and since we know that the ordinary arc sin series is convergent for all values within these limits it would seem at first thought that there should be little difficulty in determining these values.

However, since the convergence is so slow as to be practically worthless as the value of x approaches its upper limit, it becomes necessary to divide the interval of convergence into several parts and to treat the question of convergence and the consequent determination of the arc sine correspondingly.

It is found that the series is satisfactory in the interval from 0 to .5. In this interval values of the variable are found at intervals of .01 but as the values are required at intervals of .0001 the necessary interpolations are made by means of the Gregory-Newton formula.

Since $2x^2-1$ is less than .5 for values of x less than for .85 for the computation in the interval .05 – .85 the formula arc sin $x=\frac{1}{4}+\frac{1}{2}$ arc sin $(2x^2-1)$ is used.

Because of the above-named values of $2x^2-1$, the values of arc sin $(2x^2-1)$ can be found from the values previously found for the interval 0.0–0.5. This abbreviates the work of construction of the tables very greatly.

Here the same interval of .01 is used, after which the intermediate values are determined by means of the Everett formula.

For values of x greater than .85 the formula arc sin $x=\frac{1}{2}\pi-$arc sin $\sqrt{1-x^2}$ is used.

Since the tables are prepared for values out to 12 decimal places, which would normally require the use of twelve-place decimal multiplication, the tables are made much more simple by taking account of the fact that the first two terms of the decimal are identical, thus reducing the number of places required in the multiplication to ten, a *very* great saving in both labor and time.

Several tables of auxiliary quantities which are used in the computation are appended, and they add very materially to the convenience and ease with which the tables can be used.

The tables have been found to be of a high degree of accuracy and should fulfill a need in applications to the solution of various physical and engi-

neering problems. Although they were prepared primarly for the war effort, yet they will doubtless find many uses in peace time as well.

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Concise Analytic Geometry, by Charles H. Sisam, *Professor of Mathematics, Colorado College.* Cloth. Pages ix+155. 16×24 cm. 1946. Henry Holt and Company, New York. Price $2.00.

As the title would indicate, this text has been planned for a brief course, yet very little has been omitted which might be needed in later undergraduate work in mathematics. The scope of material includes the usual work on the straight line, circle, and conic sections, polar coordinates, transformations of coordinates, tangents and normals, parametric equations, and three chapters on elementary solid analytic geometry. There is an exceptionally good chapter on the discussion and graphing of an equation, including transcendental equations, and polar coordinates. There is no material on poles and polars, nor on empirical equations and curve fitting.

As might be expected of the author, the treatment is rigorous—one is pleased to find such clear cut statements as: 'lines perpendicular to the x-axis have no slope.' In the treatment of the normal form of the straight line the author chooses to restrict the angle omega to values less than 180°, while the distance p is considered a directed distance, thus differing from the treatment of some other authors.

There are more than 1,100 well graded exercises, normally from 15 to 25 in a set. In a few instances the number of exercises is so small that the problem of providing different problems in successive years might be troublesome.

The book presents a pleasing appearance. No errors were noted. The treatment would properly be called the traditional one—certainly no teacher contemplating adoption of a new text can afford not to examine this book. The explanations are exceptionally clear, illustrative examples are well selected, and the arrangement of the material should certainly be a teachable one. In general, answers are provided for the odd numbered exercises. There are no tables of any kind bound with the book.

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Curves, by Lt. Col. Robert C. Yates, AUS, *United States Military Academy, West Point, New York.* Spiral binding. Pages iii+230+iv. 14×22 cm. 1946. United States Military Academy, West Point, New York.

This work contains material relative to a large number of geometrical curves; the arrangement is alphabetical, starting with the astroid and ending with the witch. In general, the treatment is in the order: ***history***, a brief paragraph of rarely more than six lines; ***description***, which includes one or more excellently drawn graphs; ***equations***, including rectangular, polar, parametric, frequently intrinsic; ***metrical properties***, including such items as length, area, volume and surface of solid formed by revolving the curve about certain lines, radius of curvature; ***general items;*** and ***references*** (ranging from one to ten). There are more than 300 graphs. With some of the more important curves, the treatment is more extensive, for example, there are 18 pages devoted to conics.

In the alphabetical arrangement one finds certain items which perhaps

might be called topics, rather than curves, although closely related to curves. Examples are the treatment of curvature, functions with discontinuous properties, intrinsic equations, inversion, sketching. Hyperbolic functions and trigonometric functions are discussed, with many formulas included, such as derivatives, integrals, series representations. The subject of light is discussed with respect to geometric properties which in turn relate to curves.

The book is a gold mine of information. One should not consider it as a text, but rather as a very valuable source of supplementary information, to say nothing of problem material for interested students. Much of its material will no doubt be new to many teachers, as for example the statement that the limaçon of Pascal is a conchoid of a circle or the discussion of the Kieroid curve.

The arrangement of material is excellent, the book is easy to read. The index might be more complete, in some cases the reviewer found it difficult to relocate an item which attracted attention at first reading (one particular case was the use of the term *dampening factor* instead of the usual damping factor).

This book should be in very high school and college library; moreover, it might well be in the private library of every teacher of analytic geometry. One can hardly be too enthusiastic about the value of the work as a source of supplementary information.

CECIL B. READ

LECTURES ON THE CALCULUS OF VARIATIONS, by Gilbert A. Bliss, Ph.D., *The University of Chicago.* Cloth. Pages ix+296. 15×23 cm. 1946. University of Chicago Press, Chicago, Ill. Price $5.00.

This book has two parts; the first part, 184 pages, is entitled "Simpler problems of the calculus of variations," and would be suitable for a first course in the topic or form a basis for independent study. The author starts with the three dimensional situation, then later by a suitable change in notation introduces corresponding problems in the plane and in higher dimensional space.

The second part, entitled "The problem of Bolza" presents, in the words of the author, 'for the first time in book form a relatively complete treatment' of this very general problem. The book includes a 77 item bibliography of memoirs and other discussions of this problem.

The outstanding reputation of the author, particularly in the subject field, is in itself a strong recommendation of the book.

CECIL B. READ

DESCRIPTIVE GEOMETRY, by Earl F. Watts, S.B., *Associate Professor of Drawing and Descriptive Geometry, Massachusetts Institute of Technology,* and John T. Rule, S.B., *Associate Professor of Drawing and Descriptive Geometry, Chairman, Section of Graphics, Massachusetts Institute of Technology.* Prentice-Hall Inc., New York, 1946. 301 pages. Price $3.00.

This strictly up-to-the-minute test by two professors from M.I.T. is outstanding for its general organization of content. It has many features which should prove valuable to the instructor as well as to the student in the drafting room.

Starting with the principles of orthographic projection, the student is led gradually into an understanding of the fundamental problems relating to lines and planes. Replacing the traditional six fundamental problems usually found in texts on descriptive geometry, the authors have introduced ten fundamental problems to which the student is repeatedly re-

ferred throughout the book. Following each of the twelve chapters are suitable problems covering the principles developed. Many of the chapters present illustrations of methods of solving problems. These are designated as "Review Figures," clearly drawn and quickly understood. The danger of a student memorizing the pictures is lessened by the emphasis upon the *principles* illustrated in each case. Chapter three, preceding the chapter on graphical computation, is helpful in pointing out the importance of systematic solution of problems. Practice is given the student in intersection and development of surfaces, horizontal projection, as applied to map making, analytic solutions, and pictorial drawing, including perspective, isometric, and oblique views. The principles of shades and shadows are presented briefly, followed by a valuable chapter on practical applications. In it are found problems relating to structural engineering, navigation, vectors, and lofting.

In the forty-nine page appendix are helpful hints on precision drawing. A detailed description of stereoscopic drawing, which the authors state is found in no other test on descriptive geometry, is also featured in the appendix section. Enclosed in a pocket on the back cover is a polaroid vectograph. This is an especially prepared plate on which are drawn two problems as stereoscopic pairs. Viewed through the polaroid viewer, also supplied, the drawings on the vectograph appear to take three dimensional form.

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Essentials of Plane and Spherical Trigonometry, by Clifford Bell, *University of California, Los Angeles*, and Tracy Y. Thomas, *Indiana University*. Cloth. Pages ix+246. 22×15 cm. 1946. Henry Holt and Company. Price $2.00. With Table $2.30.

This book is am amplification of the first edition which was a brief text for use in the short intensive courses in trigonometry such as were needed during the wartime emergency. New sections on vectors, plane navigation, applications to surveying, complex numbers and De Moivre's theorem have been added to the plane trigonometry material. The principal addition to the spherical trigonometry consists of a complete treatment of the solution of the oblique triangle by right triangle methods.

The general definitions of the functions are introduced in Chapter I and it is believed that most instructors will favor that arrangement. However, those desiring to introduce the trigonometric functions by means of the right triangle method will find appropriate materials in Chapter II. The book is so arranged that Chapter II may be taught first, then followed by Chapter I.

Throughout the text emphasis is placed on the acquisition and development of computational skills. Each new computational technique is illustrated by several numerical examples in which every detail of the process is shown. Chapter III is devoted to a brief review of logarithms followed by a rather thorough discussion of the theory and use of the slide rule. There is a considerable number of exercises requiring the use of the slide rule to the solution of right and oblique triangles.

The exercises in this text are carefully chosen. There are about 900 in all, and they provide ample drill in the basic computational techniques. In addition there are enough challenging and difficult ones to afford ample scope for the powers of the gifted student. Those at the end of Chapter VI on oblique triangles are especially noteworthy in this respect.

This text is well written and the material is presented in a sequence which is both logical and teachable. It presents enough of the theory to provide an adequate foundation for the study of more advanced mathematics. Its main feature, however, is its thorough and lucid exposition of the computational aspects of the subject.

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SONG OF THE SOUTH

"Song of the South" is Walt Disney's first picture produced mainly with living players. It is a brilliant musical comedy-drama in Technicolor, in which the fascinating tales of Uncle Remus are interpolated naturally by the master of animation in his own incomparable style.

The youngsters who carry the principal dramatic live action, Bobby Driscoll and Luana Patten, will capture the hearts of everyone who sees this picture. James Baskett—new to films, but a well known voice on the radio, establishes himself in the character of Uncle Remus as a splendid actor with an endearing personality.

The story is a stirring, colorful, modern one of the deep South. Ten musical numbers, including new and popular songs together with favorite folk songs, are heard throughout the picture. One of them is "Zipadee Doodah," a new form of "nonsense rhyme," which will take its place with the immortal "Who's Afraid of The Big, Bad Wolf," "Whistle While You Work," and other Disney hits.

All who have had the privilege of seeing previews of "Song of the South" have hailed it as Walt Disney's greatest entertainment of his long career. We hope you will be among the first to see it and will then feel like recommending it to your group. Watch for announcement of dates at your local theatre.

BRITISH INVENTOR SHOWS NEW BRAIN WAVE ANALYZER

First demonstration in this country of a new automatic brain wave analyzer was made recently by its inventor, W. Grey Walter, Bristol, England, at the Eastern Association of Electroencephalographers meeting.

Dr. Walter claims the new analyzer will be useful in diagnosis of brain tumors and aid in the detection of mental conditions which develop into dangerous behavior irregularities. The electronic machine can tune in on 24 separate frequencies and record the impulses consecutively. It is hooked up in tandem with a standard encephalograph so that while the impulses are recorded in black ink, the analysis is recorded in red ink on the same tape.

Electroencephalographs measure the minute electrical current generated by the billions of cells in the human brain. The new instrument is designed to reduce the hours of time needed to analyze the chart which records the currents on a standard instrument.

Dr. Frederick Gibbs of the University of Illinois Psychiatric Institute said that the new analyzer failed to take account of wave forms which appear for extremely short intervals and may be clinically important. Other scientists at the Boston demonstration believed that the invention might be valuable as a supplement to existing instruments and as a research tool.